THE SECRETARY OF THE INTERIOR'S STANDARDS FOR REHABILITATION &

GUIDELINES ON **FLOOD ADAPTATION** FOR REHABILITATING HISTORIC BUILDINGS

U.S. Department of the Interior
National Park Service
Technical Preservation Services

These Guidelines were previously issued as a text-only version in November 2019. This illustrated version was revised to include diagrams, photographs, and other changes and replaces the prior version.

This publication has been prepared pursuant to the National Historic Preservation Act, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Additional information offered by Technical Preservation Services is available on our website at www.nps.gov/tps. Comments about this publication should be made to: Technical Preservation Services, National Park Service, 1849 C Street NW, Mail Stop 7243, Washington, DC 20240.

For sale by the Superintendent of Documents, U.S. Government Publishing Office
Internet: bookstore.gpo.gov Phone: toll free(866) 512-1800; DC area (202) 512-1800
Fax: (202) 512-2104 Mail: Stop IDCC, Washington, DC 20402-0001

THE SECRETARY OF THE INTERIOR'S STANDARDS FOR REHABILITATION &

GUIDELINES ON **FLOOD ADAPTATION** FOR REHABILITATING HISTORIC BUILDINGS

Jenifer Eggleston
Jennifer Parker
Jennifer Wellock

U.S. Department of the Interior
National Park Service
Technical Preservation Services
Washington, DC

2021

CONTENTS

ACKNOWLEDGEMENTS

The Guidelines on Flood Adaptation for Rehabilitating Historic Buildings was produced in response to a request for technical preservation guidance specific to historic properties at risk of flooding. A collaborative effort, the work could not have been completed without the assistance of our many preservation partners and colleagues.

We wish to acknowledge and thank the following people and organizations for their generous assistance with this publication.

Individuals from a number of groups provided valuable comments and assistance, including local preservation partners, design and other technical professionals, State Historic Preservation Offices (SHPO) and Tribal Historic Preservation Offices (THPO) throughout the country – particularly those who participated in the "Adapting Historic Buildings for Flooding" workshops in 2017 – the National Conference of State Historic Preservation Officers (NCSHPO), the National Association of Tribal Historic Preservation Officers (NATHPO), the National Trust for Historic Preservation, and our Federal agency historic preservation partners at the Advisory Council on Historic Preservation (ACHP), the Department of Housing and Urban Development (HUD), and the Federal Railroad Administration (FRA).

We especially appreciate the comments provided for this project and the prior work undertaken by the Federal Emergency Management Agency (FEMA) and their technical bulletins which were extensively referenced for this project.

We also acknowledge the contributions of the National Park Service Cultural Resources, Partnerships, and Science Directorate; our colleagues at Regional and Park-specific locations; and the staff of the Technical Preservation Services (TPS) office for their thoughtful engagement with this topic. More specifically we thank Brian Goeken for his many hours of editing and review as we finalized this publication.

The illustrations found throughout this publication would not have been possible without Tina Roach with Technical Preservation Services who coordinated this effort and the many individuals and organizations who were willing to share their photographs.

Finally, we thank the many individual property owners we met along the way that have been impacted by flooding. Your experiences and recovery helped us to understand the complex nature of the issue.

[1] The historic Shockoe Bottom neighborhood in Richmond, VA, experienced significant riverine flooding in 1985, with inundation levels reaching close to a story in height.
Photo: Jeffrey Ruggles/Virginia Commonwealth University Libraries

FOREWORD

Flooding risk has long been a major challenge for many historic properties. Changing weather patterns, stronger hurricanes, other extreme weather events, sea level rise, nuisance flooding, king tides, and continuing development in floodplains are some of the causes of flooding. Flooding events are occurring at increased frequency and magnitude. Some historic properties that have never flooded before may now be exposed to this risk, and those that flooded infrequently in the past may experience more instances of flooding or of water reaching higher levels than ever before.

The goal of the *Guidelines on Flood Adaptation for Rehabilitating Historic Buildings* is to provide information about how to adapt historic buildings to be more resilient to flooding risk in a manner that will meet *The Secretary of the Interior's Standards for Rehabilitation*. Resilience in this publication means the capacity of a historic property to withstand and recover from a flooding event.

The Guidelines on Flood Adaptation should be used in conjunction with the Guidelines for Rehabilitating Historic Buildings that are part of *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*, issued in 2017. Like the Guidelines for Rehabilitating Historic Buildings, these guidelines are intended to focus primarily on historic buildings and their sites and settings.

[2] Communities have historically employed numerous methods in response to flooding, including wholesale property buyouts and removal. The 1915 flood in Cedar Falls, WA, led to an early example of a "buyout zone" to remove buildings damaged and at risk. *Photo: Snoqualmie Valley Museum Collection: PO.074.0786*

[3] King tides and nuisance flooding are changing the way community residents live. A flooded street in Miami, FL, disrupts access to buildings and businesses. *Photo: Joe Raedle/Getty Images*

[4] As this 1933 image of North Tower Avenue in Centralia, WA, shows, flooding events have long been a major challenge for many communities. *Photo: Lewis County Historical Museum*

[5] In 2007 the Old Customs House located in the Yukon-Charley Rivers National Preserve, AK, was significantly damaged by riverine flooding. Historic properties that may not have flooded before are increasingly affected by larger flood events. *Photo: Carl Stapler/NPS*

The treatments described here are a means of preserving historic properties located in flood-prone areas and making them more resilient to flooding hazards. Flood events can be particularly destructive to historic buildings and therefore may require greater adaptive treatments. While many of these treatments can be undertaken with minimal effects on the historic character of a property, some may require more change than would normally be acceptable. Such treatments are generally not appropriate when a historic building does not have a flood risk. The treatment selected should always be one that minimizes changes to the building's historic character. Adaptation treatments should reduce the risk of flood damage as much as possible, but should do so without destroying significant historic materials, features, or spaces.

The National Park Service has developed these guidelines for adapting historic buildings to flooding risks in accordance with its directive to provide information concerning professional methods and techniques to ensure the preservation and rehabilitation of the historic properties that are an important part of the nation's heritage.

THE SECRETARY OF THE INTERIOR'S STANDARDS FOR REHABILITATION (36 CFR PART 68)

The *Standards for Rehabilitation* are codified in National Park Service regulations 36 CFR Part 68 and are regulatory only for projects receiving Historic Preservation Fund grant assistance and other Federally-assisted projects. The Standards can be used to guide work on any historic building. A separate version of the *Standards for Rehabilitation* codified in 36 CFR Part 67 is used for "certified historic structures" pursuant to the Federal Historic Preservation Tax Incentives Program.

The following Standards (36 CFR Part 68) are to be applied to specific rehabilitation projects in a reasonable manner, taking into consideration economic and technical feasibility, as well as the property's significance, existing physical condition, and available documentation.

1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces and spatial relationships.
2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces and spatial relationships that characterize a property will be avoided.
3. Each property will be recognized as a physical record of its time, place and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.
4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.
5. Distinctive materials, features, finishes and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.
7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
9. New additions, exterior alterations or related new construction will not destroy historic materials, features and spatial relationships that characterize the property. The new work will be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.
10. New additions and adjacent or related new construction will be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

THE SECRETARY OF THE INTERIOR'S STANDARDS FOR REHABILITATION

INTRODUCTION TO THE STANDARDS

The Secretary of the Interior acting through the National Park Service is responsible for establishing standards for all cultural resources programs and for advising Federal agencies on the preservation of historic properties listed in or eligible for listing in the National Register of Historic Places, including National Historic Landmarks. In partial fulfillment of this responsibility, *The Secretary of the Interior's Standards for the Treatment of Historic Properties* have been developed to guide work undertaken on historic properties; there are separate standards for preservation, rehabilitation, restoration, and reconstruction.

The *Secretary of the Interior's Standards for Rehabilitation* are one of the four sets of standards that comprise the overall treatment standards and address the most prevalent treatment. "Rehabilitation" is defined as the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historic, cultural, or architectural values.

The treatment standards were developed by the Secretary of the Interior to determine the appropriateness of proposed work on historic properties. The Standards for Rehabilitation guide Federal agencies in carrying out their responsibilities for historic properties in Federal ownership or control and are used by state and local officials in reviewing both Federal and non-Federal rehabilitation proposals. In addition, the Standards are used to determine if a rehabilitation project qualifies as a "certified rehabilitation" for Federal Historic Preservation Tax Incentive purposes. They have also been widely adopted and used by local historic district and planning commissions, local governments, non-profit organizations, design and building professionals, and the general public.

The intent of the Standards is to assist in the long-term preservation of the historic character of a property through the retention of its historic materials, features, and spaces. The Standards pertain to historic buildings of all materials, construction types, sizes, and occupancies and address both the exterior and the interior of the building. They also encompass a building's site and setting, including landscape features as well as attached, adjacent, or related new construction.

[6] Flood waters can also damage interior spaces. This historic home in Bay St. Louis, MS, was severely impacted by the storm surge from Hurricane Katrina. Even with such dramatic damage, it is crucial to properly assess the condition of historic materials and identify what remains and can be retained. In this case, most of the woodwork, the wood wainscot, upper sections of plaster in some rooms, and some areas of flooring were cleaned, dried, and repaired. *Photo: Mississippi Department of Archives and History, Mississippi Historic Resources Inventory (HRI) Database. http://www.apps.mdah.ms.gov/Public*

GUIDELINES FOR REHABILITATING HISTORIC BUILDINGS

INTRODUCTION TO THE GUIDELINES

The Standards for Rehabilitation are a series of ten principals about maintaining and preserving the historic character and features of a historic property. Guidelines give more detailed, best- practice advice to apply the Standards during project planning by providing general design and technical recommendations. Unlike the Standards, guidelines are not codified as program requirements. The *Guidelines for Rehabilitating Historic Buildings* issued in 2017 should be consulted along with any topic-specific guidelines.

Guidelines are presented in a "Recommended" vs. "Not Recommended" format. Those approaches, treatments, and techniques that are consistent with the *S*tandards for Rehabilitation are listed in the "Recommended" column on the left; those approaches, treatments, and techniques which could adversely affect a building's historic character are listed in the "Not Recommended" column on the right. These Guidelines are intended to be used in the context of rehabilitating historic buildings and include sections on a building's site and setting. They are not meant to fully address the treatment of cultural landscapes, archeological resources, historic districts, and other types of historic resources.

RECOMMENDED	NOT RECOMMENDED
Repairing masonry walls and other masonry features by repointing the mortar joints where there is evidence of deterioration, such as disintegrating mortar, cracks in mortar joints, loose bricks, or damaged plaster on the interior.	Removing non-deteriorated mortar from sound joints and then repointing the entire building to achieve a more uniform appearance.
Removing deteriorated lime mortar carefully by hand raking the joints to avoid damaging the masonry.	
Using power tools only on horizontal joints on brick masonry in conjunction with hand chiseling to remove hard mortar that is deteriorated or that is a non-historic material which is causing damage to the masonry units. Mechanical tools should be used only by skilled masons in limited circumstances and generally not on short, vertical joints in brick masonry.	Allowing unskilled workers to use masonry saws or mechanical tools to remove deteriorated mortar from joints prior to repointing.

Example of "Recommended" and "Not Recommended" format from the 2017 Guidelines for Rehabilitating Historic Buildings, page 84.

USING THE GUIDELINES ON FLOOD ADAPTATION

Unlike other versions of the Guidelines, which are organized principally by material or building feature, the *Guidelines on Flood Adaptation for Rehabilitating Historic Buildings* are organized by flood adaptation measures. The most common treatments undertaken to create more resilient properties have been included in these Guidelines and are described using definitions provided by the Federal Emergency Management Agency (FEMA). The adaptation treatments are:

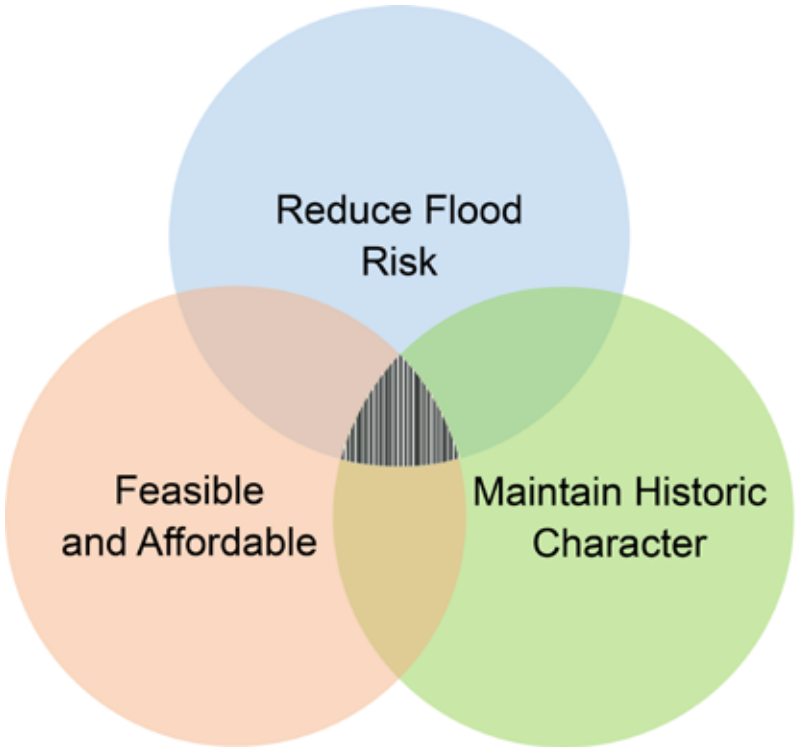
- Planning and Assessment for Flood Risk Reduction
- Temporary Protective Measures
- Site and Landscape Adaptations
- Protect Utilities
- Dry Floodproofing
- Wet Floodproofing
- Fill the Basement
- Elevate the Building on a New Foundation
- Elevate the Interior Structure
- Abandon the Lowest Floor
- Move the Historic Building

The "Planning and Assessment for Flood Risk Reduction" section should be completed for all projects prior to selecting an adaptation treatment. While "Temporary Protective Measures" and "Protect Utilities" are treatments that generally result in minimal changes to a building, **the treatment approaches are not organized in a particular order**. The impacts of the other adaptation treatments to the historic building will vary greatly depending on multiple factors such as location and site conditions of a property, historic significance, flood risk, physical and structural attributes, and its features, materials, and architectural style. For example, elevating a building on a new foundation may have a minimal impact on one building's historic character, yet for another property the same treatment may change the building's historic character significantly and not meet the Standards for Rehabilitation. Selecting more than one treatment or combining treatment approaches may be necessary to make the building more resilient to flooding and/or to minimize the impacts to the historic character and appearance of the property.

The *Guidelines on Flood Adaptation for Rehabilitating Historic Buildings* are general and intended to provide guidance in interpreting and applying the Standards to rehabilitation projects involving buildings that are at a risk for flooding. They are not meant to give case-specific advice. They cannot tell property owners or developers which features of a historic building are important in defining its historic character and, therefore, must be retained. (See *Preservation Brief 17: Architectural Character – Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving their Character*.) This case-by-case determination is best accomplished with the assistance of qualified historic preservation professionals in the very early stages of project planning. For any treatment undertaken, assemble the appropriate project team, including experienced architects, engineers, and other professionals. Obtain any necessary approvals or certifications prior to beginning work on the project.

Achieving greater resilience and reducing flood risk must be balanced with economic and technical feasibility while minimizing the impacts to the historic character of the building. These Guidelines are designed to help identify and evaluate the different adaptation options in order to select a treatment that meets the Standards for Rehabilitation. Wherever possible, the Guidelines provide "Recommended" methods of implementing each type of adaptation in order to preserve as much of the historic character of a building and its site and setting as possible. All of the "Recommended" treatments may not apply to every project. Technical limitations are identified for each treatment.

These Guidelines do not address disaster response or short-term recovery. The Guidelines may be used after a flood event as properties undergo rehabilitation and adaptation to address the damage and future flooding risk. Limited information about drying and cleaning after a flood is included with Wet Floodproofing because it is an integral part of that adaptation.



[7] Technical and economic limitations must be considered when attempting to reduce flood risk and create greater resilience; changes must also respect the historic character of the property. This can be a challenging balance for a project to achieve.

"The Guidelines on Flood Adaptation for Rehabilitating Historic Buildings should only be applied to historic properties with an established risk of flooding."

The *Guidelines on Flood Adaptation for Rehabilitating Historic Buildings* should only be applied to historic properties with an established risk of flooding. This risk can be determined by quantifiable and/or science-based projections or a community model or projection for flood risk areas. Such maps and models take into account river flow, storm tides, hydraulic analysis, rainfall, and topographic surveys among other factors.

A project meets the Standards when the overall effect of all work is consistent with the property's historic character. **Treatments that might not be considered in other rehabilitation contexts because of their impacts on the historic character of a property may be acceptable in the context of adapting the property to flooding hazards.** Even in this context, the selected treatment should always be one that minimizes the changes to the building's historic character and appearance while addressing the risk. Adaptation treatments should increase the building's resilience to flooding risks as much as possible, but should do so without destroying significant historic materials, features, or spaces.

The entire scope of the project, including alterations related to flood adaptation as well as any other work to the building or site, must be evaluated. The amount of change to features and spaces that can be accepted within the Standards will vary according to the roles they play in establishing the character of the property.

Aspects less critical to the historic character may be altered more substantially with less effect on the character of the building as a whole. However, the cumulative effect of changes that are numerous or substantial can in some instances alter the overall character of the building, in which case the rehabilitation project will not meet the Standards.

Finally, the Guidelines address unconventional treatments and situations when a historic building may not be able to be retained and preserved. Demolition is not a treatment that meets the Standards for Rehabilitation. These two sections are included solely for informational purposes.

"Treatments that might not be considered in other rehabilitation contexts because of their impacts on the historic character of a property may be acceptable in the context of adapting the property to flooding hazards."

ASSESSING THE RISK AND SELECTING AN ADAPTATION TREATMENT

Before undertaking any work to adapt a historic building to be more resilient to potential flooding, research about the actual flood risk as well as about the historic property must be undertaken. Proposed alterations to the property will need to be adequate to address the identified risk.

Property owners should take into account the characteristics of the potential flood. These characteristics include the direction the water will likely flow, the expected speed and depth of the water, the duration of the flood, whether there will be wave action, the potential for water-borne debris, the water salinity, and contamination of the flood waters. The applicable Federal, state, and local code requirements and regulations must also be considered.

[8] Understanding the characteristics of a flood are critical to understanding property risk. Significant structural damage occurred to this building as a result of a riverine flood in Cedar Rapids, IA, in 2008. *Photo: Greg Januska*

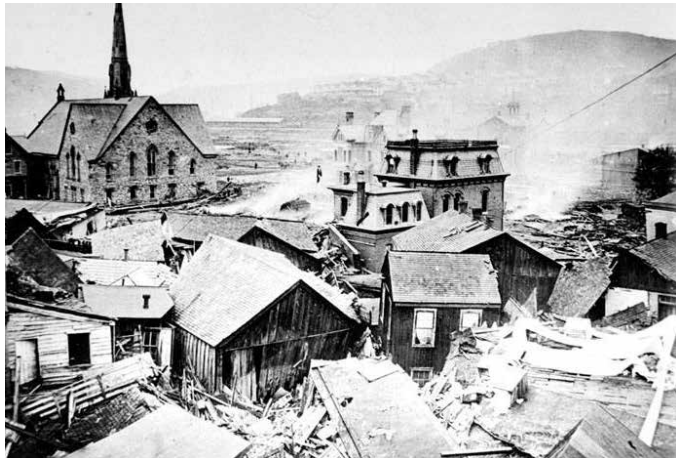
[9] Fast-moving flood waters can undermine a foundation or scour out land around a building. The Little Church of the Pines in Salina, CO, was left structurally compromised after heavy rains caused flooding in the Front Range of the Rocky Mountains in 2013. *Photo: Burton Construction burton-construction.com*

"Established flood risk level" describes the property-specific height of anticipated floodwater."

These guidelines use the term **"established flood risk level"** to describe the property-specific height of anticipated floodwater. This measurement should be based upon recognized flood data, past flood events, site-specific reports, and other applicable information. Often this height is dictated by local floodplain ordinances and codes and can be higher than the predicted flood level. In order to remain more general, this document purposefully does not use terms for flood risk defined by other agencies. The use of "established flood risk level" is an attempt to avoid confusion and the appearance of providing interpretation of Federal, state, and local regulatory terms for flood risk.

Prior to planning or undertaking any work, the spaces, features, materials, and finishes of the historic property affected by the flooding or the proposed adaptive treatment should be documented. The property's existing capacity to sustain and recover from flooding, as well as its physical condition and use, should be evaluated. Those spaces, features, and materials that are important to the historic character and significance of the property should be identified for retention and preservation. Existing materials and features that provide additional resiliency to flooding may also be considered for retention, improvement, or enhancement. In regions where buildings were historically adapted to frequent flooding, traditional treatment approaches should be considered.

It may also be helpful to consider adapting a historic property in scalable phases, particularly for coastal properties at risk from rising sea levels and increasing flood risk. Where the magnitude and time horizon of the risk are uncertain, it is important to build in future capacity where economically and technically feasible – for example, a flood wall with an



[10] The Great Johnstown Flood of 1889, caused by a catastrophic dam failure, shows the extent of damage that can occur from a large-scale, fast-moving flood event. Whole buildings were destroyed, others were shifted from their foundations, and massive amounts of debris caused considerable loss of life, damage, and destruction. *Photo: NPS*

[11] Flood forces are powerful and can result in a building being shifted from its foundation. This historic property in Gulfport, MS, was knocked off of its piers by Hurricane Katrina in 2005. *Photo: Jennifer V.O. Baughn/ Mississippi Department of Archives and History, January 26, 2006*

over-engineered foundation that can be extended higher in the future.

These Guidelines are intended to assist property owners undertaking a flooding adaptation project, recognizing that, as with any rehabilitation project, there are always other design, programmatic, financial, and regulatory requirements that must also be considered in planning such projects. Among these, the National Flood Insurance Program (NFIP) may have significant financial impacts and influence design decisions. The NFIP is administered by the FEMA and implemented by state and local governments. This program is responsible for providing flood insurance, improving floodplain management, and developing Flood Insurance Rate Maps (FIRM). These Guidelines are not an attempt to interpret or provide guidance on the NFIP or which treatments may or may not reduce flood insurance costs.

The NFIP includes a provision that provides relief for historic buildings from certain floodplain requirements. The provision is applied at the discretion of state or local governments and might not be available to all historic property owners. It is not designed to reduce flood risk or insurance rates. The NFIP uses the term "historic structures" (44 CFR Part 59) and defines them as follows:

- Listed individually in the National Register of Historic Places or preliminarily determined by the Secretary of the Interior as meeting the requirements for individual listing on the National Register.
- Certified or preliminarily determined by the Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district.
- Individually listed on a state inventory of historic places in states with historic preservation programs which have been approved by the Secretary of the Interior.
- Individually listed on a local inventory of historic places in communities with historic preservation programs that have been certified either by an approved state program as determined by the Secretary of the Interior or directly by the Secretary of the Interior in states without approved programs.

The provision for historic buildings within the NFIP allows for alternative compliance when prescriptive flood code requirements would result in a project that does not meet the Standards for Rehabilitation. However, using this provision to avoid taking any steps to address or help minimize the flood risk of a historic property is not recommended.

The following sections describing the adaptation treatments are intended to provide information about potential preservation concerns so that property owners can engage in active decision-making about how to adapt their historic buildings to be more resilient to flooding risk. Evaluations, documentation, and planning are critical but should result in a timely and purposeful decision. Factors including flood risk, economic and technical feasibility, and historic character should be appropriately balanced and inform the decision-making process. The decision should result in an adaptive treatment and implementation plan for the property or documentation explaining why no action is currently necessary. Good stewardship requires making a choice.

(a) *Graphic: FEMA*

(b) *Graphic: Adapting to Rising Tides*

[12] Maps can help property owners identify the flood risks at their site, and it may be necessary to consult a number of sources for this information.
(a) Flood Insurance Rate Maps (FIRM) are created by a program within the Federal Emergency Management Agency (FEMA). They are regulatory and are the official maps that show special flood hazard areas. (b) Community flood models or supplementary maps adopted by a local jurisdiction may include more data, future projections, or other flood risk information. Comparing these two maps for the northeast quadrant of San Francisco, the modeling shown in (b) includes sea level rise data and identifies additional sections of the city that are likely to flood.

PLANNING AND ASSESSMENT FOR FLOOD RISK REDUCTION

For historic properties at risk of flooding, treatments should be undertaken to avoid or minimize the impacts and to ensure the continued preservation of the property and its historic character. Planning and risk assessment for potential flooding should therefore be undertaken proactively, and properties should be maintained in good condition, monitored regularly, and appropriately documented as part of any treatment plan for the property.

A historic building may have existing characteristics, features, or materials that themselves have inherent resilience to flood hazards and can help address or minimize the impacts of flooding. When applicable and appropriate these characteristics, features, or materials should be taken into consideration early in the planning stages of a rehabilitation project before proposing any new treatments. When new adaptive treatments are needed, they should be carried out in a manner that will have the least impact on the historic character of the building, its site, and setting. In adapting a building to be more resilient to flooding risks, the goal should always be to minimize the impacts to the building's historic character to the greatest extent possible. It is helpful to record the decision-making process for future evaluation.

[13] The Church of Our Lord Chapel, Karluk, AK, was built in 1888 and is the oldest Russian Orthodox Church in Alaska. In danger of collapse into the Karluk River, the erosion of the bluff has been rapidly escalating, and the church sits only 25 feet from the edge. The vulnerability of the property at the edge of a river requires frequent monitoring, but a more long-term solution will be necessary for the continued preservation of the building. *Photo: Tom Pillifant*

All planning and assessment for reducing flood risks should include the following:

- Identify the historic property's flood risks and vulnerabilities and any existing capacity for resilience.
- Monitor the condition of the property and regularly reevaluate its flooding risks and vulnerabilities.
- Document the historic property. *The Secretary of the Interior's Standards for Architectural and Engineering Documentation* or *Preservation Brief 43: Preparation and Use of Historic Structure Reports* can serve as a guide.
- Review and understand the compliance requirements of the local floodplain ordinance and related local regulations.
- Identify and assess all feasible adaptation treatment options to determine how they will address the flooding risk.
- For each treatment option, evaluate the impacts of any potential alterations to the historic property's character-defining spaces, features, and materials, and its site and environment.
- Consideration should be given to how local communities have decided to adapt to the risk of flooding hazards and treat historic properties impacted by these risks. Also consider the future viability of community infrastructure, such as roads, sewers, and other utilities and services.
- Select the time frame for which the adaptation treatment is expected to adequately reduce the risk. This could be tied to the length of a mortgage or some other point in the future.
- Always select an adaptive treatment that minimizes the impacts to the historic character and appearance of an individual property and/or a larger historic district.

(a) *Photo: Greg Hartman/*The Catholic Telegraph

(b) *Photo: Hawaiian Electric*

(c) *Photo: Tom Foster*

[14] (a) Flood markers like this one in Cincinnati, OH, can provide evidence of past flood events and serve as a community reminder of the risk of flooding. (b) This tsunami marker located in Hilo Bay on Moku Ola Island, HI, (c) notes the high wave heights along the trunk of a coconut palm tree. A nearby interpretive marker discusses the damage done by significant past storms.

[15] Surveying and documenting existing building conditions is always recommended prior to implementing an adaptation strategy. NPS Historic American Building Survey (HABS) staff photograph the 1833 Lockkeepers House on the National Mall in Washington, DC, prior to the building's relocation and restoration. *Photo: Heritage Documentation Programs/NPS*

PLANNING AND ASSESSMENT FOR FLOOD RISK REDUCTION

RECOMMENDED	NOT RECOMMENDED
Identifying historic materials, features, and spaces that are important in defining the historic character of the property when planning and undertaking flooding adaptation treatments.	
Developing and implementing a plan to reduce the risk of damage or destruction to the historic building.	Failing to proactively analyze and address a flooding risk.
Identifying and evaluating the vulnerabilities of the historic property to the impacts of flooding using the most current climate information and data available.	Failing to identify and periodically reevaluate the potential vulnerability of the building, its site, and setting to the impacts of flooding.
Assessing the potential impacts of known vulnerabilities on character-defining features of the building, its site, and setting. Reevaluating and reassessing potential impacts on a regular basis.	
Documenting the property and character-defining features as a record and guide for future repair work, should it be necessary, and storing the documentation in a safe location with at least one duplicate at a secure site.	Failing to document the historic property and its character-defining features with the result that such information is not available in the future to guide repair work.

PLANNING AND ASSESSMENT FOR FLOOD RISK REDUCTION

RECOMMENDED	NOT RECOMMENDED
Maintaining the building, its site, and setting in good repair, and regularly monitoring character-defining features.	Failing to regularly monitor and maintain the property and the building systems in good repair.
Using and maintaining existing historic and non-historic characteristics, features, and materials of the historic building, its site, setting, and larger environment (such as a site wall that keeps out flood waters) that may help to avoid or minimize the impacts of flooding.	
Undertaking work to prevent or minimize the loss, damage, or destruction of the historic property while retaining and preserving significant features and the overall historic character of the building, its site, and setting.	Carrying out adaptive measures intended to address the impacts of flooding that are unnecessarily invasive or will otherwise adversely impact the historic character of the building, its site, or setting.

(a) *Photo: Tina Roach/NPS*

(b) *Photo: Jennifer Wellock/NPS*

(c) *Photo: Taylor Masonry*

[16] Maintenance of existing exterior features such as roofing and gutters can help a building be more resilient to flood and storm events as well as assist in the long- term preservation of the property. (a) Moss on the roof and plants growing in the gutter indicate a wet condition and clogged gutter. (b) A disconnected downspout has been allowed to undermine the foundation and expose the building's sanitary system. (c) Masonry along the sidewalk shows signs of rising damp and salt damage. Stopping decay as a preventative measure is one way to manage long-term risk and damage from flooding.

PLANNING AND ASSESSMENT FOR FLOOD RISK REDUCTION

RECOMMENDED	NOT RECOMMENDED
Ensuring that, when planning work to adapt for flooding, all feasible alternatives are considered, and that the options requiring the least alteration are considered first.	Failing to plan for flood risk and to make a treatment decision, even if the decision is that no intervention is currently necessary.
Replacing damaged or deteriorated historic materials in kind where the traditional material is flood-damage resistant. Replacing damaged or deteriorated historic materials that are not resilient to flooding with proven flood-damage resistant substitute materials that match the appearance and design.	

[17] (a) Interior woodwork at the Charnley-Norwood House, known as Bon Silene, in Ocean Springs, MS, withstood a storm surge of 30 feet from Hurricane Katrina in 2005. Interior walls, ceilings, and cabinetry are constructed of curly heart pine. Milled from the heart of Longleaf pine trees, heart wood is known to be insect and rot resistant. (b) The restoration project, which included repairs to the interior wood paneling, was completed in 2014.

(a) *Photo: Mississippi Department of Archives and History, Mississippi Historic Resources Inventory (HRI) Database. http://www.apps.mdah.ms.gov/Public (altered)*

(b) *Photo: Tall Architects*

PLANNING AND ASSESSMENT FOR FLOOD RISK REDUCTION

RECOMMENDED	NOT RECOMMENDED
Utilizing local and regional traditions (such as elevating residential buildings) for adapting buildings in response to flooding when compatible with the historic character of the building, its site, and setting.	Utilizing an adaptation treatment traditionally used in another region or one typically used for a different building type or architectural style which is not compatible with the historic character of the property.
Using special exemptions and variances when prescribed adaptive treatments to protect buildings from flooding would otherwise negatively impact the historic character of the building, its site, and setting, while still taking steps to address or help minimize flood risk.	Using a special exemption or variance to avoid taking any steps to address or help minimize the impacts of flood risk on a historic property.

(a) *Photo: Long Island Museum*

(b) *Photo: Nancy Solomon/Long Island Traditions*

[18] (a) This bay house, known as the Pidherney House, sits along Reynolds Channel on the South Shore of Long Island, NY. Bay houses were not primary residences, but simple and resilient structures used as base camps for clamming, fishing and hunting. The buildings rest on mudsills supported by piers above the wetlands. Most have a porch or deck that faces south for prevailing winds and incorporate features such as a hatch (b) which enabled water to enter and exit the building during an extreme high tide.

PLANNING AND ASSESSMENT FOR FLOOD RISK REDUCTION

RECOMMENDED	NOT RECOMMENDED
Considering adaptive options, whenever possible, that would protect multiple historic resources, if the treatment can be implemented without negatively impacting the historic character of the overall historic property, district, or archeological resources, other cultural or religious features, or burial grounds.	Failing to consider other properties nearby in planning flood adaptations, therefore increasing the risk or exposure to neighboring properties.
Reassessing the risks, property conditions, and local, state, and federal regulations on a regular schedule and after any flood event.	

[19] Community-scale interventions, such as this combination of a flood wall, levee, and floodgates in Galena, IL, can protect multiple historic resources and maintain the character and integrity of entire historic districts and neighborhoods. *Photo: GalenaGuide.com*

[20] Temporary measures such as sandbags can be a simple and inexpensive solution for protecting buildings in low-lying and vulnerable areas, but they are not meant to withstand moving floodwaters for extended time periods. *Photo: Eduardo Munoz/Reuters*

[21] A rural homeowner has deployed a water-filled temporary dam or water bladder to act as a floodwall around their residence. Water bladders require a storage area when not in use and the resources and time to fill them when a flood is imminent. *Photo: Aqua Dam, Inc*

[22] This floodgate is a temporary solution that can only be deployed with enough notice of a potential flood event. Storage of the gate apparatus must be on or close to the property with ready access in order to be actively deployed. *Photo: Liz Petrella/NPS*

[23] A combination of different temporary measures can be an effective short-term solution to flooding. In this case, a building wrap of waterproof fabric is anchored by sandbags. *Photo: Chapelboro.com*

TEMPORARY PROTECTIVE MEASURES

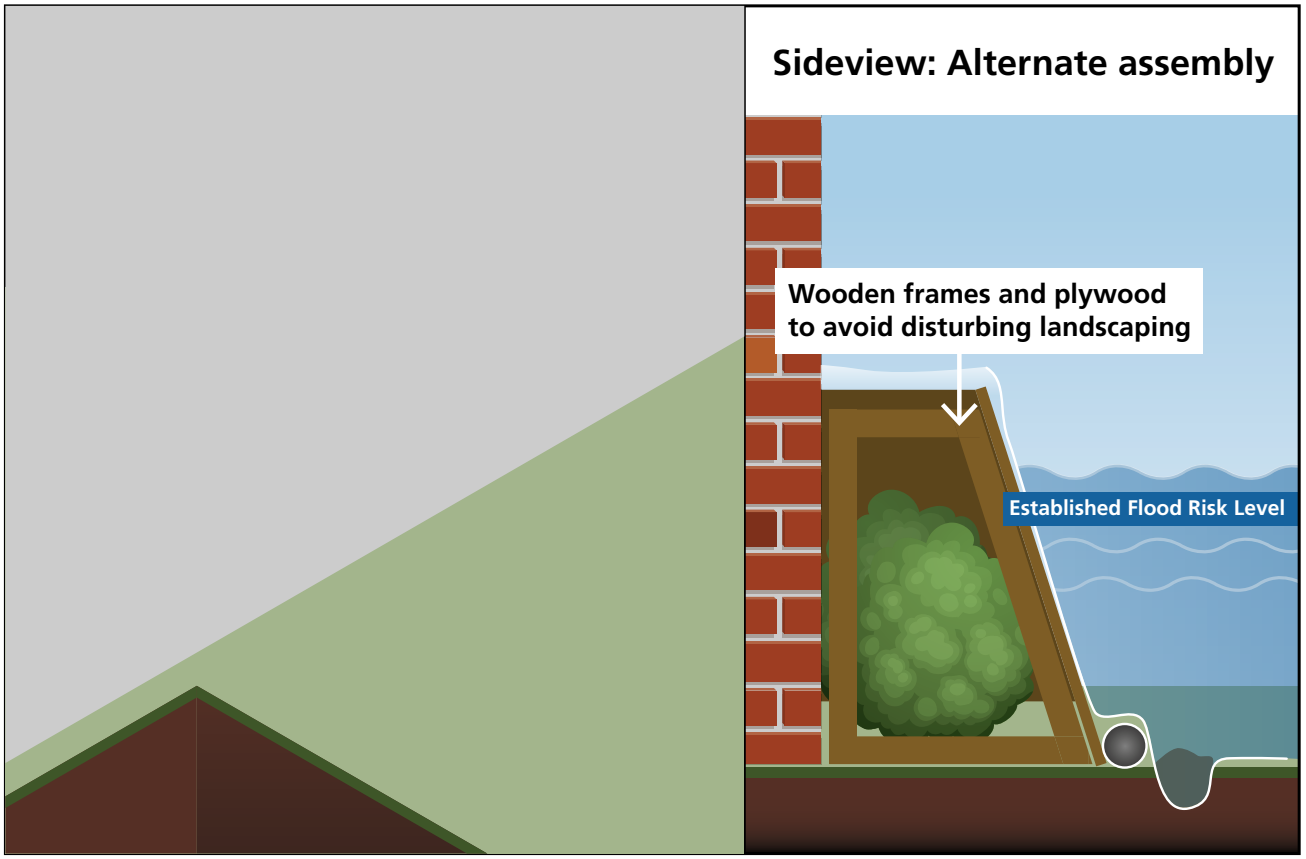
Temporary or non-permanent protective measures use materials or systems that can be deployed or activated when flooding is predicted and removed or stored when the flood waters have receded. Temporary measures are generally the most affordable options and can have a low impact on the historic character of the property because they rarely involve permanent changes to the property. However, temporary measures may not be well suited for areas subject to frequent flooding. Temporary measures require time and people to quickly deploy them, so they are not a good option in locations where flooding may occur without sufficient warning time. Although someone may need to be on site to deploy the system, property owners or tenants themselves should secure the property as best they can and move to a safe location outside the flood zone for the duration of the event.

Temporary measures include sandbags, temporary dams, temporary floodgates, and flood-wrapping systems. Sandbags are the most widely recognized tool used to protect a property from flood water, but there are also synthetic products that function in a similar fashion. Temporary dams are intended to encircle a building or close gaps in floodwalls. Temporary floodgates are removable barriers installed in windows, doorways, and other openings. Flood wrapping systems cover the most vulnerable portion of an existing structure to create a temporary impervious barrier. Wrapping systems do not lend additional strength or stability to a structure, therefore any building using such a system must be able to withstand the forces of the flood.

No temporary system is failproof. There can be water seepage with these materials and systems, and they should be used in conjunction with pumps and emergency generators. Generators should be elevated above the established flood risk level or located within a floodproof enclosure. If a temporary measure is breached or overtopped, the deployed system should be removed to promote drying once it is safe to return and flood waters have receded. With any of these systems, if custom-sized or special components are needed for certain locations (like a floodgate for a specific-width opening), it is important that they be easy to locate and identify to facilitate timely installation when flooding is predicted.

Technical Limitations:

- Temporary protective measures are generally designed for relatively shallow floods of limited duration.
- Deployment takes time and varies depending on the equipment or system and the labor available to put it in place.
- Equipment requires storage space, and, if stored off site, the logistics of getting the temporary barrier or system to the site must be factored into deployment time.
- During a flood event, temporary measures must not rely on continual on-site monitoring, as evacuation from the flooded area may be required until emergency personnel allow property owners to return.



[24] This diagram illustrates the installation of a temporary waterproof building wrap on a historic masonry building. The fasteners should be attached at the mortar joint and not directly into the brick or stone. The wrap should continue below grade to help protect the property from scour and potential seepage. An alternate installation method (also illustrated) involves constructing a wood frame to support the wrapping material and can be placed around plantings or other site features. *Graphic: Blank Space LLC for NPS*

TEMPORARY PROTECTIVE MEASURES

RECOMMENDED	NOT RECOMMENDED
Selecting a temporary barrier, system, or equipment that will protect the historic building from the predicted type of flooding and that can be deployed using the labor, equipment, and warning time available.	Selecting a system or equipment inadequate to protect the historic building from predicted flooding and/or cannot be deployed in time.
Evaluating and ensuring the ability of masonry walls and temporary flood barriers or other systems covering masonry openings to withstand the forces of flooding. Reinforcing walls as necessary to withstand such forces.	Reinforcing masonry walls to withstand the forces of flooding in a manner that destroys historic materials and features or diminishes the historic character of the property.
Installing fastening devices or stanchions to attach the temporary barrier or system in concealed or secondary locations of the building, and in a manner that does not damage, alter, or otherwise impact the historic character of the property.	Installing fastening devices or stanchions where they would damage, alter, or otherwise impact the distinctive materials, features, and spaces of the property.

[25] Permanent stanchions at windows and doors in this former industrial mill in Baltimore, MD, are used to attach temporary floodgates to protect openings in the event of a flood. Depending on their size, color, and finish, these stanchions can be quite noticeable. In the case of an industrial property, this may not cause a significant change in historic character. In a different type of building, it is important to ensure that such permanent features blend in and are as visually unobtrusive as possible. *Photo: Jennifer Parker/NPS*

TEMPORARY PROTECTIVE MEASURES

RECOMMENDED	NOT RECOMMENDED
Establishing procedures, responsibilities, and regular training for deploying temporary barriers and other systems.	
Installing pumps to remove water that breaches the temporary barrier or other system. Ensuring that the water is pumped an adequate distance to avoid seeping back in.	
Investing in a generator as a backup to operate pumps if there is a power failure during or after a flood. Installing a generator in a floodproof enclosure or above the established flood risk level.	

[26] Water can still seep through sandbag barriers. A property owner should have a pumping system with back-up generators to remove water from behind the barrier. *Photo: Ted Jackson, NOLA.com* | The Times-Picayune. The Advocate, *7/29/2019*. The Times-Picayune/The Advocate

TEMPORARY PROTECTIVE MEASURES

RECOMMENDED	NOT RECOMMENDED
Providing sufficient clearance between the temporary barrier and the walls of a historic structure to ensure that the force of the water against the barrier is not transferred to the historic building.	Erecting temporary barriers that are in direct contact with any significant historic building, structure, or object on the site.
Obtaining removable flood barriers for openings in any existing solid masonry perimeter site walls that are strong enough or reinforced to withstand the forces of a flood.	
Relocating furnishings and valuable collections to higher floors, upper shelves, or off-site to protect them from seepage or possible failure of the temporary barrier or system. Using water-tight containers for storage whenever possible.	Assuming that temporary barriers or other systems will keep out all water and, therefore, not planning ahead for possible seepage or failure of a temporary barrier or system.

(a) *Photo: New Jersey Historic Trust*

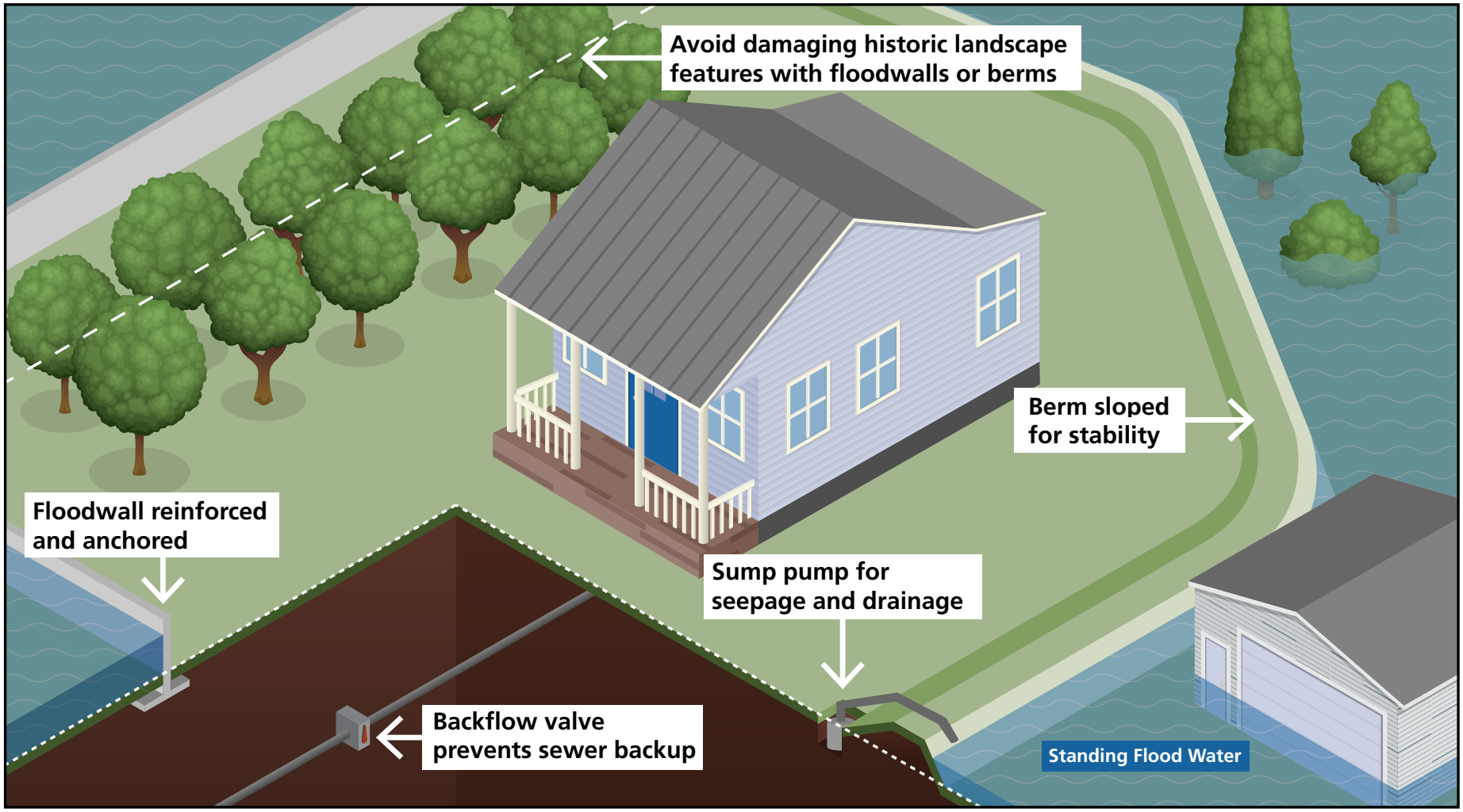
(b) *Photo: Ocean City Department of Public Works and Office of Emergency Management*

[27] (a) This historic train station in Ocean City, NJ, has installed permanent stanchions in the historic wood door jamb. (b) When flooding is predicted, temporary floodgates can slide into the stanchions to keep water from entering low-level openings. The permanent stanchions are a dark color that blends with the dark brown historic wood door jambs.

(a) *Photo: Andy Abeyta*

(b) *Photo: Paramount Theatre*

[28] The Paramount Theatre in Cedar Rapids, IA, has combined exterior and interior temporary protection measures. In this example, (a) the exterior of the lobby has been protected by a temporary waterproof building wrap anchored with sandbags. (b) Interior seats can be removed at the lower levels and stored safely. Should flood waters enter the building, interior elements will not be damaged or become waterborne debris.



[29] New site structures like a floodwall or berm can protect a historic property from flooding. When choosing a location, avoid damaging or interrupting the historic setting and its significant site and landscape features. There should be a method to remove water that enters the site in the form of rain, seepage through barriers, or overtopping. *Graphic: Blank Space LLC for NPS*

SITE AND LANDSCAPE ADAPTATIONS

A range of site and landscape interventions can be implemented to protect a historic building from flooding, both on the property itself as well as off-site. The advantage of these options is that the historic building generally remains unaltered. The relationship of a building to the site and setting is important to the preservation of historic character.

Changes to the site and landscape should be carefully planned to avoid negatively impacting the property's historic integrity and any historic landscape features, archeological resources, and other cultural or religious features. Site and landscape changes can also impact the integrity of a historic district.

The different types of site interventions include basic regrading, large engineered structures, and infrastructure projects that may protect many properties in a neighborhood or district. Storm-water management systems, berms, and floodwalls can all be used to control water on a single site, and each of these site interventions can also be 'scaled up' to protect multiple properties and larger areas. Levees and the restoration of natural flood control systems like living shorelines, dunes, marshes, and wetlands are additional tools for larger-scale interventions.

Site mitigation will change how water moves through and around a property. Altering the existing site conditions must be done with thoughtful examination of potential impacts to neighboring properties adjacent to and downstream from a property.

Technical Limitations:

- Site or landscape adaptation measures can make flooding worse for other properties, and codes or regulations may not allow their use in certain locations.
- Adding a new site or landscape feature is not possible on-site for properties that are already on fully developed sites (i.e., the building occupies the majority of the lot), although it may be possible to modify an existing feature like a site wall.

[30] This low-scale floodwall in Washington state provides flood protection without compromising the historic character of the property or obstructing views of the historic house from the street. A deployed floodgate can seal the opening at the driveway during a flood event. *Photo: French Wetmore*

[31] This small-scale levee or berm has provided flood protection to this property in Chase County, KS, since the 1940s. *Photo: Steve Samuelson*

(a) *Photo: New Leaf Redevelopment Consulting*

(b) *Photo: New Leaf Redevelopment Consulting*

[32] A new permanent floodwall incorporated the edge of (a) an existing loading dock to serve as (b) both flood protection and guard rail at the former Smulekoffs Furniture Store in Cedar Rapids, IA.

[33] A large floodwall protects the historic downtown of Cape Girardeau, MO, from the Mississippi River. *Photo: VisitCape*

[34] Some flood protection structures are historic, such as this seawall in St. Augustine, FL. The seawall was constructed in sections over time beginning in 1696 near the Castillo de San Marcos. *Photo: Jennifer Wellock/NPS*

(a) Photo: *Tina Roach/NPS*

(b) *Photo: US Army photo by Alfredo Barraza*

[35] (a) Stone-clad floodwalls on the National Mall in Washington, DC, provide anchor points for (b) a temporary paneled floodgate that can be installed in the gap to protect downtown Washington from Potomac River flooding. This structure is part of the District of Columbia Levee System constructed by the U.S. Army Corps of Engineers and operated and maintained by the National Park Service (NPS). The NPS annually practices closing the gate across 17th Street to ensure performance and to practice preparedness. Located between the Washington Monument and the Lincoln Memorial, it is designed to blend into the historic landscape.

[36] Raised streets may require additional access points to residential and commercial properties if the sidewalks and buildings are not also raised. This 1890s historic example from Old Salem, NC, incorporated new brick stairs and railings. Additional considerations for accessibility would need to be addressed today.
Photo: Jennifer Wellock/NPS

SITE AND LANDSCAPE ADAPTATIONS

RECOMMENDED	NOT RECOMMENDED
Identifying, retaining, and preserving features of the historic site and setting that are important in defining its overall historic character before undertaking site mitigation work or changing the landscape or its features.	Removing or substantially changing site features that are important in defining the overall historic character of the property so that, as a result, the historic character of the property is diminished.
Altering the site or setting in locations that are not critical to the significance of the historic character of the property.	Damaging or destroying significant historic landscape features, designs, or plantings in order to establish a new site or landscape feature to protect the property from flood risks.
Retaining the topography and historic relationship between buildings and the site and setting. Elevating roads, sidewalks, and infrastructure along with buildings in a coordinated and planned effort while maintaining the historic spatial relationships and setting to the greatest extent feasible.	Changing the grade level of the site if it substantially diminishes its historic character.

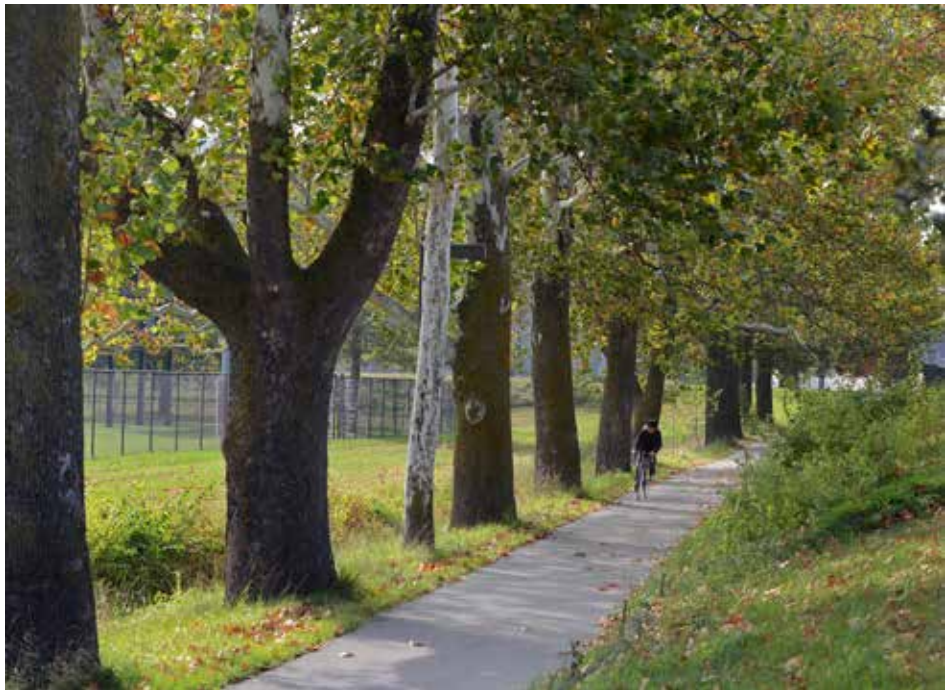
[37] Following the 1900 Hurricane that devastated Galveston, TX, a large portion of the island was raised by elevating the buildings and adding new fill. (a) This historic image shows the original grade with buildings in the process of being put on raised foundations and the newly elevated road under construction. (b) The same view after the roads and sites were elevated.

(a) *Photo: Courtesy of the Rosenberg Library, Galveston, Texas*

(b) *Photo: Courtesy of the Rosenberg Library, Galveston, Texas*

SITE AND LANDSCAPE ADAPTATIONS

RECOMMENDED	NOT RECOMMENDED
Protecting and maintaining buildings, site, and landscape features by providing proper drainage to ensure that water does not erode foundation walls, drain toward the building, or damage or erode the landscape.	Failing to ensure that site drainage is adequate so that buildings and site features are damaged or destroyed. Changing the site grading so that water does not drain properly or is redirected toward other buildings or structures.
Surveying and documenting areas where the terrain will be altered or new features constructed to determine the potential impact to important landscape features, archeological resources, other cultural or religious features, or burial grounds.	Failing to survey the building site prior to beginning work, which may result in damage or loss of important landscape features, archeological resources, other cultural or religious features, or burial grounds.



[38] Historic landscape features should be protected and avoided when selecting a location for berms, levees, or floodwalls. At Iowa State University in Ames, IA, a line of approximately 50 sycamore trees known as “Sycamore Row” marked a historic path that connected university grounds. In 2013, a new berm proposed to protect a nearby building was relocated so that the trees would not be removed. *Photo: Inside Iowa State*

SITE AND LANDSCAPE ADAPTATIONS

[39] Street and sidewalk improvements that include bio-swales or other water retention systems can be effective devices to collect or direct water and alleviate flooding as shown here in Milwaukee, WI. *Photo: Liz Petrella/NPS*

RECOMMENDED	NOT RECOMMENDED
Avoiding and protecting (e.g., preserving in place) important site features, archeological resources, other cultural or religious features, or burial grounds.	Leaving known site features or archeological material unprotected so that it is damaged as a result of adaptation work.
Planning and carrying out any necessary site investigation before adaptation work begins, using professional archeologists and methods, when preservation in place is not feasible.	Allowing unqualified personnel to conduct archeological investigations, which can result in damage or loss of important archeological material.
Improving or restoring on-site or adjacent natural systems such as living shorelines, wetlands, and beaches and dunes. Selecting new infrastructure that is able to retain floodwaters on site, such as a cistern, bio-swale, permeable pavers, green roofing, and associated rain collection systems.	
Designing new or improving existing storm-water management systems to reduce surface floods and reverse-flow flooding (water moving backward through the system to flood through drains).	Damaging or destroying historic materials, features, or spaces of the historic building, site, and setting in order to add or improve storm-water management.

SITE AND LANDSCAPE ADAPTATIONS

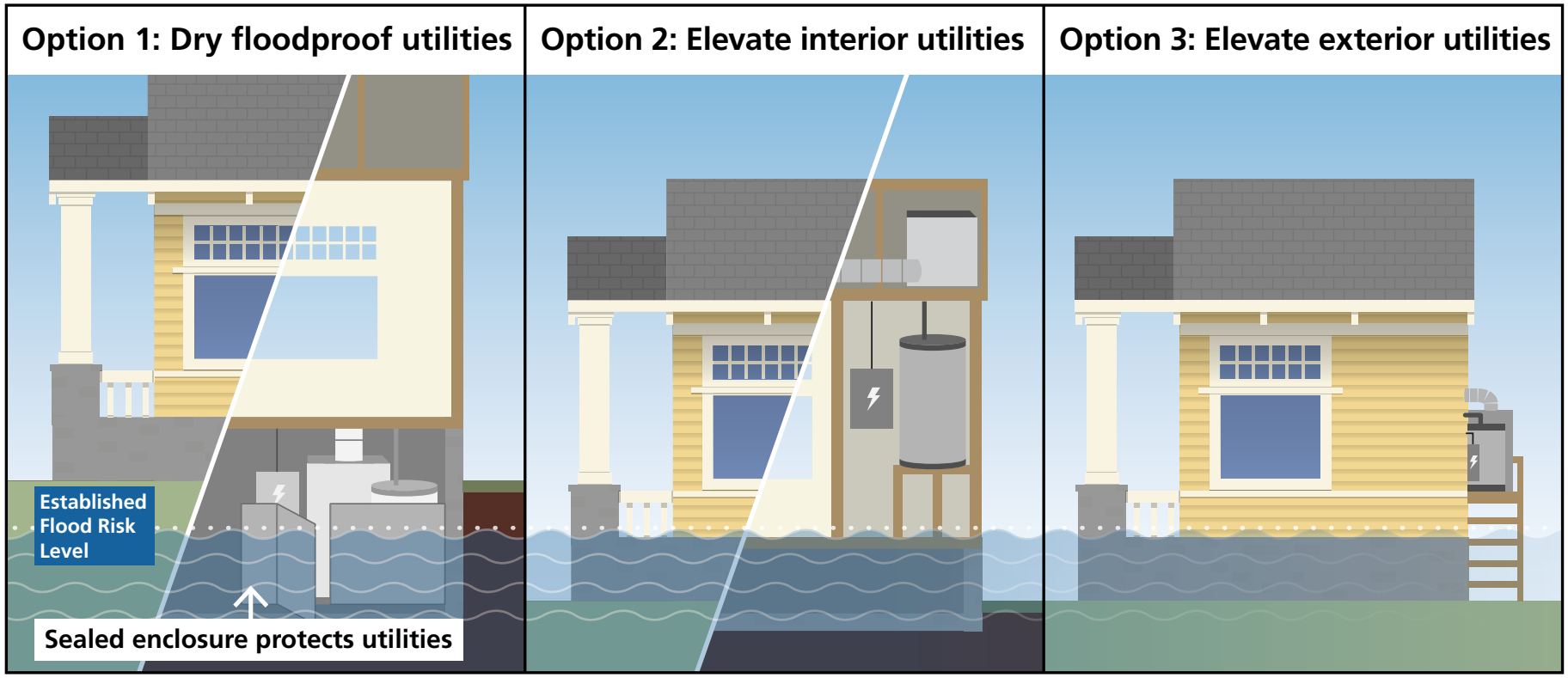
RECOMMENDED	NOT RECOMMENDED
Constructing a levee, berm, or embankment on adjacent or nearby land outside the historic site or district to minimize impacts to the character of the historic property and increase the area of protection for the historic site or district. Designing a new floodwall or berm or improving an existing barrier to provide flooding protection to a historic site.	Damaging or destroying important landscape features, archeological resources, other cultural or religious features, or burial grounds in order to construct the flood protection.
Ensuring that the new or modified floodwall or berm is compatible with the historic character of the property.	Constructing a tall floodwall or berm that is incompatible with the historic character of the site or setting such that it blocks the property from significant viewsheds, or alters the appearance of the property from the public right-of-way.

(a) *Photo: National Archives*

(b) *Photo: National Archives*

(c) *Photo: National Archives*

[40] (a) At the National Archives in Washington, DC, an existing site wall was modified to provide flood protection. A new self-closing floodgate was installed behind an existing historic gate to create a continuous barrier. (b) The floodgate is recessed into the ground. (c) During a flood event, the rising waters will activate hydraulic controls at the gate, causing it to rise within the opening and block water from entering the lower levels of the building.



[41] There are three options for protecting vulnerable portions of mechanical, electrical, and plumbing systems from flood damage. They can be protected in place with waterproof enclosures, moved to a higher location within the building, or located on an exterior elevated platform, roof, or other elevated location. *Graphic: Blank Space LLC for NPS*

PROTECT UTILITIES

Utilities and mechanical systems for historic buildings are often placed in basements to conceal them from sight. Any part of these systems that is in flood-vulnerable locations should be elevated or relocated above the established flood risk level. Utilities and mechanical systems should be relocated to utilitarian or insignificant spaces in historic buildings that are unlikely to flood. Exterior utilities and mechanical systems should similarly be elevated to protect them from flooding and placed in locations that minimize as much as possible their visibility and impact on the historic character and appearance of the building.

When planning a project involving mechanical, electrical, plumbing, or fire suppression systems, it is helpful to be aware of the service life of the various features of the systems involved. Sometimes it may be necessary to keep the systems, in whole or in part, in the existing location even though it is a known flood risk area of the property. This part of the system will need to be placed within a watertight enclosure or be sacrificial and replaced after a flood. Depending on the frequency of expected flooding, the cost of that part of the system, and its expected service life, sacrificing system components may be economically reasonable.

The protection of utilities should be addressed as part of any adaptation treatment. While utilities are not specifically addressed in all other treatments described in these Guidelines, this section is generally applicable.

Technical Limitations:

- The new location for the equipment must provide adequate space and meet ventilation requirements.
- The relocated equipment must be accessible for monitoring, servicing, and inspection.

PUBLIC UTILITIES

RECOMMENDED	NOT RECOMMENDED
Relocating all utilities above the established flood risk level or protecting them in place with a watertight or impermeable enclosure.	Relocating systems and utilities to a historically significant interior space or a highly visible location.
Relocating and anchoring exterior mechanical equipment and fuel tanks to an elevated platform that is compatible with the building's historic character and is, preferably, on a secondary or otherwise less visible elevation.	Constructing a new platform for exterior equipment with incompatible materials and/or in a highly visible location if it can otherwise be avoided.

[42] Mechanical equipment that remains in a basement that is likely to flood should be enclosed behind waterproof walls. The walls may be partial height, as shown in this example, if flood waters are not expected to exceed that height. In other cases, waterproof enclosures must fully surround the equipment, which can be accessed by submarine-quality doors or hatches. *Photo: Quinn Evans*

PUBLIC UTILITIES

RECOMMENDED	NOT RECOMMENDED
Using fencing or landscaping to screen exterior mechanical equipment and reduce its visibility.	
Relocating interior mechanical equipment to utilitarian or insignificant spaces within the building that are unlikely to flood.	

[43] Relocating mechanical equipment in interior spaces should be limited to utilitarian spaces like closets or mechanical rooms. *Photo: Mary Lane Carleton*

[44] Access issues must be considered when relocating exterior mechanical equipment on an elevated platform. If electrical or gas meters are moved to higher locations, stairs or a ladder may be required by the utility company to facilitate meter reading. *Photo: p3elevation.com*

PUBLIC UTILITIES

RECOMMENDED	NOT RECOMMENDED
Relocating ducts, pipes, and conduit to spaces that are unlikely to flood to the extent practical; and concealing such systems within walls, attics, chases, and soffits in historically-finished spaces.	Relocating ducts, pipes, and conduit to primary spaces and leaving them exposed, or concealing the systems in a manner that will change the overall character of the space.
Insulating the outside of ducts in the established flood risk area so that insulation can be removed after a flood to promote drying.	Selecting ducts with integral insulation that is not flood-damage resistant and will be located in the established flood risk area.
Installing an electrical disconnect well above the established flood risk level in an easy to access location. This should be separate from the utility panel.	
Eliminating electrical service to (or separating it from) flood-prone areas of the building or site with minimal disturbance to historic features and finishes.	Damaging or destroying historic interior or exterior features, finishes, or materials to an excessive degree in order to access wall cavities for re-wiring.

(a) *Photo: Marilou Ehrler/NPS*

(b) *Photo: Denver Service Center/NPS*

[45] The exterior mechanical equipment of (a) this historic barracks building at Fort Hancock in Sandy Hook, NJ, was (b) elevated on an exterior platform at the back of the building. The platform was designed to have a minimal profile and painted a dark color to blend in with the building foundation.

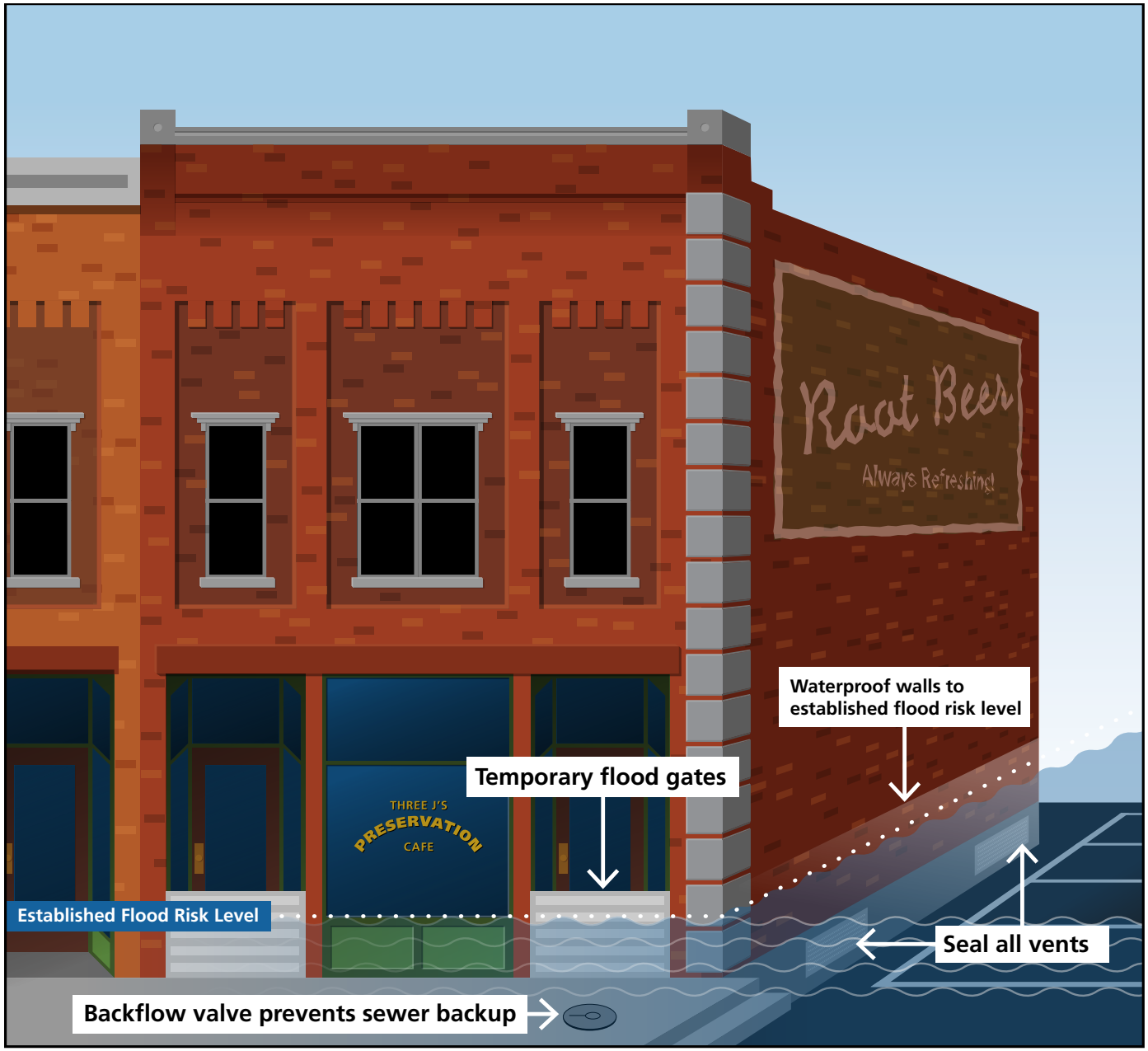
PUBLIC UTILITIES

RECOMMENDED	NOT RECOMMENDED
Installing backflow prevention devices in water and sewer lines.	
Installing sump pumps at the lowest level of the structure that are powered by a back-up power source.	

[46] For many buildings in flood-prone areas, having a generator on site may be a necessity to provide emergency power for pumps and other mechanical equipment. This public library in Hoboken, NJ, has a generator located on a flat roof high above any flood waters and not visible from the street. *Photo: David V. Abramson for Hoboken Public Library*

Case Study

Protect utilities is a treatment that is often combined with other adaptations. To learn about how several treatments, including utility relocation, were used in combination at a historic property, refer to Case Study 4: Combined Flood Adaptations to Protect a Rhode Island Livery on page 139.



[47] Dry floodproofing is intended to keep all flood waters out of a building. This adaptation will include waterproofing walls, sealing openings, and installing backflow prevention devices. Any waterproof coatings should be carefully researched before applying them to historic wall surfaces and materials. *Graphic: Blank Space LLC for NPS*

DRY FLOODPROOFING

Dry floodproofing is an adaptation method designed to keep water out of a building. This treatment requires establishing a watertight seal on the exterior of the foundation and sealing all interior spaces below the established flood risk level. This adaptation measure may involve significant alterations that impact historic spaces, features, and materials affecting the building's historic character and appearance. In order to dry floodproof a property, all openings (windows, doors, and any utility penetration) that extend or are completely below the established flood risk level must be designed to be temporarily or permanently sealed. Exterior foundation surfaces must be impervious to water. This can be accomplished with a waterproof coating or membrane. Walls must be reinforced and anchored to withstand flooding forces, including buoyancy and debris impact, and an engineered drainage system must be installed. Impacts to historic character are likely to be less for buildings where dry floodproofing is only necessary below grade, thus eliminating the visibility of the alterations.

The aspect of dry floodproofing that can pose the greatest concern from a preservation perspective is waterproofing. There are numerous products and technologies that are available, from tar to synthetic materials, and each product has different performance standards and the potential to negatively impact the historic materials to which it is applied.

[48] A waterproof coating is applied to the interior surface of lower-level walls of the public library in Hoboken, NJ. Prior to applying such a coating, the product should be researched by building science professionals with knowledge of historic materials and methods to ensure that the coating will not cause damage to or accelerate deterioration of the structure. *Photo: David V. Abramson for Hoboken Public Library*

It is important that a product be thoroughly researched before applying it to a historic building, properly applied, and monitored after installation. Waterproof coatings are vapor impermeable and can trap moisture in the wall or on the interior wall surface and cause deterioration or damage to historic materials.

Because of the strength of flood forces, dry floodproofing is generally not recommended for projected flood inundation levels that are more than three feet, particularly for unreinforced masonry. This adaptation method will require a high frequency of maintenance when exposed to repeated flooding. It is a more appropriate treatment to use where the flood risk is infrequent or below three feet.

Technical Limitations:

- This adaptation method is only appropriate for load-bearing masonry buildings or frame buildings with masonry foundations where the established flood risk level is below the top of the foundation since masonry walls can be made to withstand flooding forces.
- The treatment requires regular maintenance, monitoring, and repair to perform effectively in repetitive flood events, as system components such as sealants and membranes can degrade or become damaged.
- This method is not recommended if flooding is anticipated at levels higher than three feet due to structural and other considerations.
- Any building component below the established flood risk level, which could include foundations, walls, slab, stair, or sanitary systems, must be able to withstand hydrostatic forces.

STRUCTURAL CONSIDERATIONS

RECOMMENDED	NOT RECOMMENDED
Evaluating the strength of masonry walls and footings of historic buildings to ensure that they are strong enough to withstand floodwater pressure and flood-borne debris.	Proceeding with dry floodproofing without assessing the structural stability of the historic building.
Anchoring the structure to the foundation with engineered solutions, to prevent movement or collapse of the historic building.	Altering visible foundation walls to an extent that the historic character of a building is compromised.

(a) *Photo: Liz Petrella/NPS*

(b) *Photo: Liz Petrella/NPS*

[49] These photos from an industrial mill in Baltimore, MD, show (a) the structural reinforcing required at large window openings that extend below the established flood risk level. Rather than blocking these windows, either permanently or temporarily, the owner elected to use aquarium glass in the lower sash. The steel reinforcing will later be concealed by wood trim. Certain compromises in the glass color and transparency, as well as frame details and muntin profiles, were necessary to accommodate the thicker glass in the lower sash. Photo (b) shows a side-by-side mock-up of two options for simulated muntins on the aquarium-glass panels on the lower sash.

SITE DRAINAGE

RECOMMENDED	NOT RECOMMENDED
Preparing to effectively manage the incoming floodwaters and addressing moving and removing the water from the site and historic building after the flooding.	
Installing a drainage system around the foundation and footings of the historic building to avoid undermining the building and to allow for proper site drainage.	Ignoring potential impacts to the historic landscape, archeological features, or other historic resources that could be caused by the installation of a drainage system.
Installing a backflow valve to prevent sewer and drain backups.	
Installing one or more sump pumps, if needed, to effectively control water on the site and reduce hydrostatic pressure post-flooding.	

[50] To keep water out of a building, openings on secondary elevations may be permanently infilled with masonry to match or blend in with the walls. Any sills or lintels should be preserved in place, and the masonry infill should be inset to preserve the historic fenestration pattern. *Photo: Jennifer Parker/NPS*

COVERINGS AND COATINGS

RECOMMENDED	NOT RECOMMENDED
Designing temporary or permanent closures for all openings (i.e., windows and doors) that are below or extend into the established flood risk level while maintaining the historic character of the building. Blocking character-defining window or door openings on a primary or highly visible façade that extend into the flood protection zone with temporary flood shields. Blocking openings on secondary elevations or in less visually prominent locations with temporary flood shields or compatible masonry infill recessed within the opening to retain the profile of the opening.	Blocking character-defining openings such as the historic building's windows and doors permanently in a nonreversible manner.

(a) *Photo: National Flood Protection*

(b) *Photo: National Flood Protection*

[51] Even temporary flood shields may require permanent stanchions or fasteners. (a) At this garden entrance door in Charleston, SC, mounting panels and anchors are permanently installed. The mounting panels are painted the same color as the building to minimize their appearance. (b) When a flood event is predicted, the temporary stanchions and flood panels may be fixed in place.

[52] Permanently installed flood barriers can be designed to be compatible with a building's historic features and character, as with this operable flood door on a circa 1770 commercial building in Ellicott City, MD. *Photo: Liz Petrella/NPS*

(a) *Photo: Belk Architecture*

(c) *Photo: Courtesy of Chrysler Museum of Art*

(b) *Photo: Flood Panel LLC*

[53] There are many options for temporary flood barriers at doors and storefronts. (a) At Revolution Mill in Greensboro, NC, the barrier is located on the interior side of the opening. Racks on the adjacent wall provide a permanent onsite storage location for the panels. (b) A post-and-panel barrier system on this Main Street commercial building provides a narrow profile design that protects the storefront without encroaching on the public sidewalk. (c) A jamb-mounted panel system is set back in an arcaded entrance at the Chrysler Museum of Art in Norfolk, VA.

COVERINGS AND COATINGS

RECOMMENDED	NOT RECOMMENDED
Installing stanchions, fasteners, or tracks for flood shields in concealed or secondary locations, and in a manner that does not damage, alter, or otherwise impact the historic character of the property.	Installing flood shield fasteners where they would damage, alter, or otherwise impact the historic character of the property.
Building a low wall or curb around basement windows that is compatible with the historic building to keep flood waters out.	

(a) *Photo: Doug Kerr https://creativecommons.org/licenses/by-sa/2.0/*

(b) *Photo: Mark G. Benz*

[54] Burnham Memorial Hall in Lincoln, VT, uses temporary flood barriers with permanently installed stanchions to prevent water from entering through basement-level windows and doors. The stanchions are noticeable, but do not significantly impact the historic character and appearance of the building due to their location on a secondary elevation.

[55] A low flood wall or curb that is compatible with the historic character of the property can be constructed around basement windows to keep flood waters out. *Photo: Jennifer Parker/NPS*

COVERINGS AND COATINGS

RECOMMENDED	NOT RECOMMENDED
Installing required air vents in foundation walls that can be sealed in the event of flooding.	
Covering or coating the exterior of foundation wall surfaces with a proven waterproof membrane or coating at or below the established flood risk level. Wrapping the foundation with a temporary, removable waterproof membrane instead of applying a permanent waterproof coating, when possible.	Covering or coating portions of the walls above the established flood risk level.

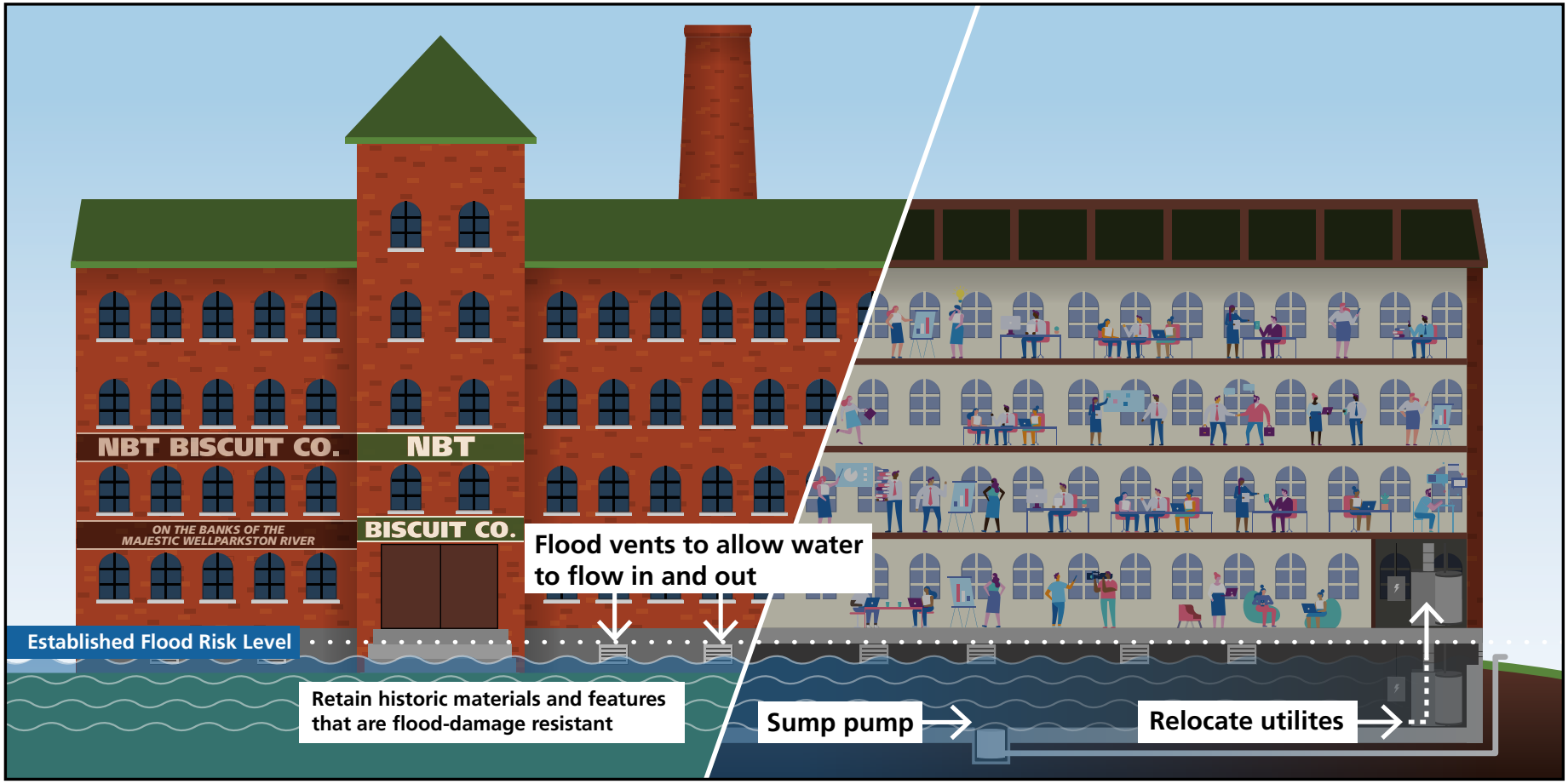
[56] To create a watertight seal around the building, any existing vents or openings below the established flood risk level must be sealed during a flood. Vents that cannot be sealed internally will require an exterior and/or interior cover to keep water from entering the building. *Photo: Chelius Carter*

COVERINGS AND COATINGS

RECOMMENDED	NOT RECOMMENDED
	Applying coatings or coverings in a manner that alter or damage the historic character of the building.
Applying a waterproof coating on the building that is compatible with and does not damage the historic masonry.	Applying a waterproof coating that is incompatible with the historic masonry or that is not watertight and could cause damage or deterioration.
Inspecting applied coatings or membranes on a regular basis to ensure performance and periodically reapplying the coating or replacing the covering.	Failing to maintain a waterproof coating or membrane after it has been applied, or reassessing it after a flood event.

Case Study

To learn about how this treatment was used at a historic property, refer to Case Study 1: Dry Floodproofing a Wisconsin Main Street Building on page 127.



[57] Wet floodproofing as an adaptation allows water to safely enter and exit a building during a flood event. Utilities must be relocated or protected, and openings or flood vents are required to allow water to flow in and out of the building. Any historic or other materials in the spaces that will flood must be flood damage resistant. A sump pump is needed to drain the floodwater.
Graphic: Blank Space LLC for NPS

WET FLOODPROOFING

Wet floodproofing allows water to enter a historic building during a flood event and drain out as the flood waters recede. It is not recommended where flooding is expected to exceed 24 hours in duration. Because this approach allows flood waters to enter the building, which will likely cause damage to historic materials, features, and finishes, it is best to limit this treatment to buildings where the area of inundation is an unfinished space if the building is not constructed of flood damage-resistant materials.

Wet floodproofing requires water to move in, through, and out of the building at a consistent rate, largely controlled by vents. The total number, size, and locations of the vents or openings is based on the square footage of the building and the anticipated performance of the vents. Water must also be able to move through the interior spaces of the flooded portions of the building, such as through doors and other openings. The building may require structural reinforcement and anchoring to the foundation to allow it to withstand the force of the flood waters.

All mechanical, electrical, and plumbing systems must be elevated above the established flood risk level or otherwise designed to withstand floodwaters (see Protect Utilities). Where the floodwater may not drain naturally from the lowest levels of the property, a drainage system must also be designed and installed to help remove the water from the building.

(a) *Photo: Local 4 News/WHBF-TV*

(b) *Photo: City of Davenport, Iowa*

[58] This property located in Davenport, IA, experienced a significant flooding event in the spring of 2019. The (a) engineered vents at the base of the wall (b) allowed the flood waters to move in, through, and out of the building at a controlled rate.

Interior spaces must be altered to allow for inundation, potential contamination, draining, cleaning, and drying. This can require removal and replacement of historic materials. If the lower level is finished, materials that will be in contact with the water may need to be replaced with more water-resistant and impervious materials. For example, gypsum wall board will need to be completely removed and replaced with a flood-damage resistant substitute material such as marine-grade wood to avoid moisture and mold issues. Because water will wick up through many materials, a horizontal waterstop joint is recommended to limit the amount of materials that will require drying and cleaning.

Any wall cavities will need to be opened and accessed after each flood to clean and dry. Additionally, all interior furnishings and personal effects must be moved from the area prior to the flooding event to protect them from damage of the flood waters. After the flood, the cleaning process can involve harsh chemicals, power washing, and additional material removal and replacement. Be aware that drying and cleaning can take extended periods of time, and the building may not be habitable during this process. The drying process can be moderately accelerated by using dehumidifiers and fans.

[59] Flood waters can have a significant impact on historic building interiors. Historic features and materials can often be retained and repaired and should not be preemptively removed or replaced. Much of the interior of this flooded historic property in Gulfport, MS, was able to be cleaned and retained.
Photo: Jenifer Eggleston/NPS

The primary preservation concern about this adaptation method is the potential loss of historic materials. It is crucial to identify and document the condition of the historic materials, features, and finishes before selecting this treatment. Some traditional materials perform as well as recommended modern flood-damage resistant materials and should be retained. Many historic buildings have been altered over time and may no longer retain a high degree of historic interior materials or features (e.g., plaster has been replaced with drywall). In these instances it may be possible to replace those features with flood-damage resistant material without impacting the historic character of the building. Flood-damage resistant substitute materials may be used to replace deteriorated or damaged historic materials and features below the established flood risk level.

This adaptation method is generally not appropriate for a historic building that still retains a high level of historic materials, features, and finishes that are not flood-damage resistant at or below the established flood risk level because it could result in their loss.

Technical Limitations:

- This adaptation is not viable for buildings where flooding will likely exceed 24 hours due in part to the potential for damage, contamination, and biological growth possible over longer exposures to floodwater.
- Any building component below the established flood risk level, which could include foundations, walls, slab, stair, or sanitary systems, must be able to withstand hydrostatic forces.
- The building has to dry out after a flood, so this method is not suitable if there is inadequate ventilation of the flooded area.
- This adaptation requires a lengthy cleaning process and drying time, and, therefore, is best selected when flood waters will be limited to non-living spaces (i.e., basements, crawlspaces, garages, etc.) or for nonresidential properties.

(a) Photo: Ken Uracius/Stone & Lime

[60] Fort Jefferson located on the Dry Tortugas, FL, in the Atlantic Ocean exists in a wet environment with high salinity levels. (a) The iron components embedded in the masonry walls have reacted to these environmental factors, causing rust jacking, spalling masonry, and partial collapses (Exterior walls are shown before and (b) after repairs). Properties exposed to saltwater flooding are likely to encounter additional or accelerated damage and deterioration and may need materials science professionals involved in adaptation project planning.

(b) *Photo: Ken Uracius/Stone & Lime*

STRUCTURAL NEEDS

RECOMMENDED	NOT RECOMMENDED
Evaluating the strength of walls and footings of historic buildings to ensure that they are strong enough to withstand floodwater pressure and flood-borne debris.	Proceeding with wet floodproofing without assessing the structural stability of the historic building.
Anchoring the structure, where necessary, to prevent movement or collapse of the historic building.	Altering visible foundation walls to an extent that the historic character of a building is affected.

UTILITIES

RECOMMENDED	NOT RECOMMENDED
Relocating all utilities above the established flood risk level or protecting them in place with a watertight or impermeable enclosure.	Relocating systems and utilities to a historically significant interior space or a highly visible location.
Installing a Ground Fault Circuit Interrupter (GFCI) to protect the electrical system of the historic building and prevent possible fires.	

[61] This electrical box is protected with a removable waterproof plastic covering. Alternatively, electrical outlets can be located above the flood inundation level. *Photo: Liz Petrella/NPS*

(a) *Photo: Jenifer Eggleston/NPS*

(b) *Photo: Jennifer Wellock/NPS*

[62] The design, materials, and placement of existing and new foundation vents should be considered as a property is wet floodproofed. (a) If the vents are on primary or highly visible facades like this historic property in New Orleans, LA, their retention is recommended. (b) New vents can be made to match historic vents, but it might be necessary to install more of this type than those that are specifically engineered to operate during a flood.

SITE DRAINAGE AND VENTING

RECOMMENDED	NOT RECOMMENDED
Following the recommended structural engineering guidance for the number, size, and placement of hydrostatic flood vents, as well as any other ventilation requirements.	Ignoring industry standards for flood venting requirements resulting in the loss of structural stability of the building in a flood event.
Retaining historic foundation vents in highly visible locations where feasible.	Selecting a non-engineered vent system (i.e. faux historic) where engineered vents would result in significantly fewer openings in the foundation.
Selecting a compatible design and placement for new vents, or painting vents to blend in with the foundation material.	Installing vents in highly visible locations without consideration of rhythm of fenestration.
Designing a system for draining the building as flood waters recede outside the building.	Failing to regulate the rate of water draining from the property, potentially causing structural damage to the building or neighboring properties.

[63] When new venting is required, the placement and design should be compatible with the existing property. The insulated, engineered vent added to the door of this property in Sandy Hook, NJ, has been painted to blend in. *Photo: Tina Roach*

INTERIOR ALTERATIONS

RECOMMENDED	NOT RECOMMENDED
Retaining historic materials, features, and finishes that are flood-damage resistant. Removing non-historic finishes and furnishings that absorb and trap moisture, such as carpets.	Removing intact, undamaged, or repairable historic materials, features, and finishes in anticipation of a possible flood.
Using substitute materials that are more flood-damage resistant when replacing deteriorated or destroyed historic materials and features that are compatible with the historic character of the building. Replacing character-defining features with a substitute material that matches the design and appearance of the historic component.	Selecting flood-damage resistant replacement materials and features that are potentially destructive or incompatible with the historic building.

(a) *Photo: Shannon O'Hara*

(b) *Photo: Shannon O'Hara*

[64] The Bendit House built in 1953 and located in Houston, TX, experienced flooding in 2017 during Hurricane Harvey. Much of the original brickwork, terrazzo flooring, and solid lumber millwork was cleaned, repaired, and retained. Some of the newer paneling and more porous surfaces had to be replaced to allow for drying and repair.

INTERIOR ALTERATIONS

RECOMMENDED	NOT RECOMMENDED
Relocating, if necessary, electrical outlets and panels above the established flood risk level in a manner compatible with the historic character of the building by placing them in less visible locations and possibly concealing them with existing features such as a door frame or chair rail.	Relocating electrical outlets or panels above the established flood risk level in a highly visible location that impacts the historic character of the interior spaces.
	Making new openings in walls which damage or destroy historic materials and features or otherwise impact the historic character of the building in order to allow the movement of water.
	Applying impermeable coatings that cannot be easily removed, or otherwise sealing the building envelope in a way that may cause damage to the building.
Relocating furnishings and possessions to higher floors, upper shelves, or off-site to protect them from flood waters.	Leaving furnishings and possessions in the flooded part of the building resulting in flood-borne debris.

[65] Flood waters often must be actively pumped out of and away from the property, as seen in this image from Des Moines, IA. The pumping process should be designed to control the shift in hydrostatic pressure on the building and remove all flood waters that do not naturally drain or recede from the property. *Photo: Chris Snider*

The following wet floodproofing treatments are intended for interior spaces that have been significantly altered in the past or irrevocably destroyed or damaged such that the spaces possess a low level of historic integrity. These treatments do not meet the Standards for Rehabilitation if the interior spaces still retain a high level of historic materials, features, or finishes, because it could result in their loss and significantly diminish the building's historic character.	
RECOMMENDED	**NOT RECOMMENDED**
Installing interior flood-damage resistant materials in a manner that limits destruction of the historic materials and features.	Selecting flood-damage resistant materials that are incompatible and potentially destructive to the historic envelope.
Using flood-damage resistant substitute materials that are compatible with the existing historic interior finishes and character.	Installing flood-damage resistant materials without considering their impact on the historic character of the building.
Selecting and installing impervious materials that allow air circulation within the building envelope.	Installing and applying materials and treatments that prevent the proper movement of air and water vapor through the building envelope or interior walls.
Installing a horizontal waterstop joint in the wall that prevents the wicking of moisture during a flooding event in a manner that does not compromise the structural integrity of the wall or causes the loss of intact historic features.	Removing or damaging structural materials and intact historic features to install a water- stopping joint in a wall.

Case Study

For more information about wet floodproofing a historic building, refer to Case Study 2: Wet Floodproofing a New Jersey Cottage on page 131.

[66] In order to limit the absorption of flood waters, a horizontal waterstop joint can be installed in a building's walls depending upon the wall material and construction. This was also done historically, as shown in this historic brick wall with slate embedded in the mortar to limit water wicking up the wall. *Photo: eagle/stock.adobe.com*

PROPERTY CLEAN-UP POST-FLOODING

RECOMMENDED	NOT RECOMMENDED
Using the gentlest means possible for effectively removing surface grime and killing flood-borne bacteria. This can include a low-pressure water wash and appropriate cleaners.	Using abrasive materials or methods to clean the flood-impacted building.
Identifying and assessing the flood-damaged building to determine the impacts to the historic materials and features. Determining which materials and features can be cleaned, dried, and repaired and which materials must be replaced.	Removing flood-impacted materials and features without proper assessment or consideration of their historic value or ability to be cleaned and repaired.
Allowing all the materials that were submerged or in contact with the flood waters to properly dry using dehumidifiers and fans before repairing the building.	Accelerating or force drying the building with heat in order to expedite repair of the damaged building.

(a) *Photo: Jenifer Eggleston/NPS*

(b) *Photo: Karen Gadbois https://creativecommons.org/licenses/by-sa/2.0/ (altered)*

(c) *Photo: Rusty Costanza, The Times-Picayune, 8/28/2010. The Times-Picayune/The Advocate*

[67] (a) The "Steamboat Houses" (built 1905 and 1913) in New Orleans, LA, are located in close proximity to the Mississippi River and were constructed to withstand flooding. Much of the ground-floor (b) exterior and (c) interior of the houses were constructed of glazed brick, tile floors, and hardwoods that can be dried out, gently cleaned, and put back into use.

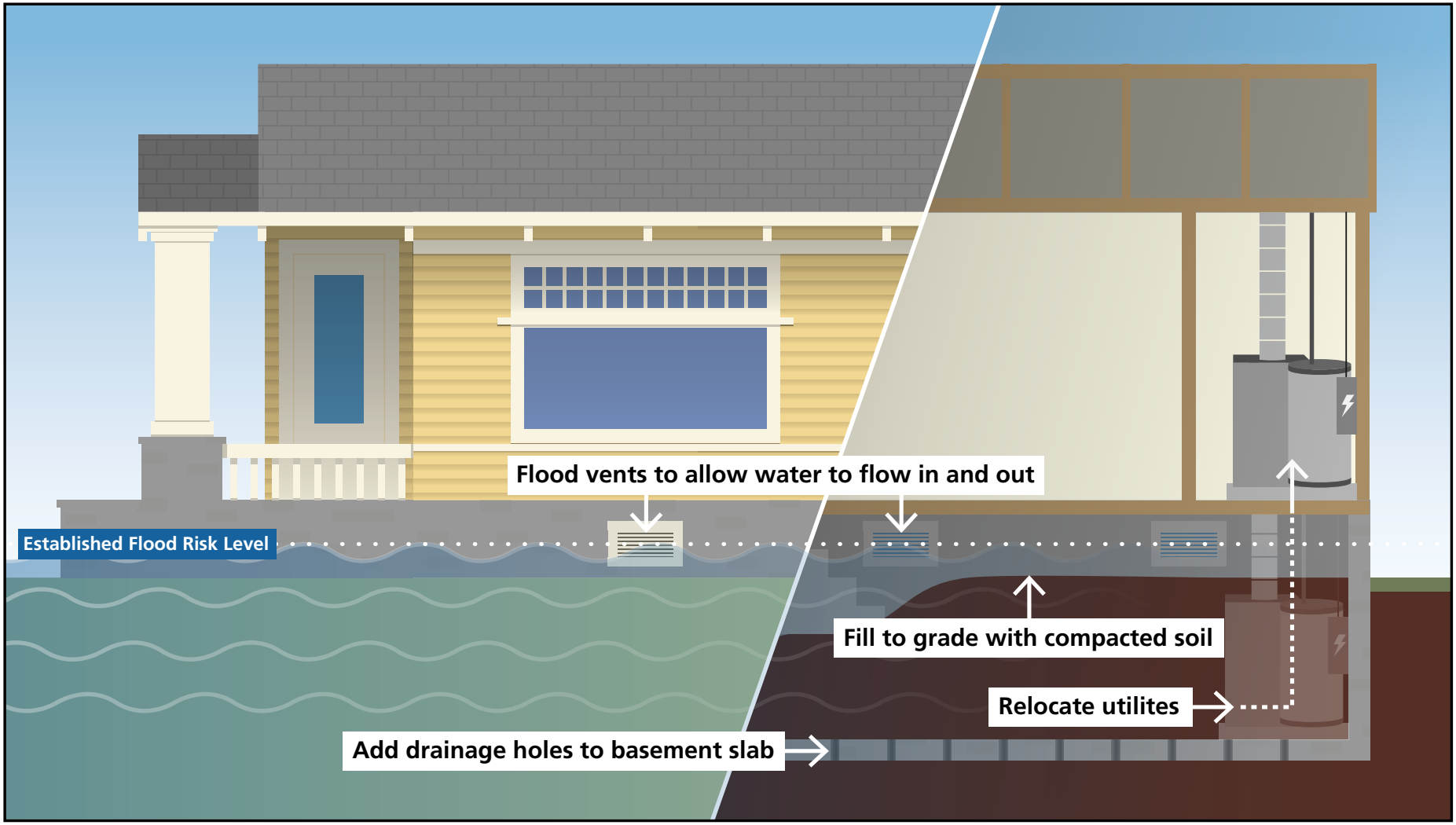
(a) *Photo: Reid Thomas/North Carolina Historic Preservation Office*

(b) *Photo: Reid Thomas/North Carolina Historic Preservation Office*

[68] Opening portions of walls, bringing in fans and dehumidifiers, and moving materials that have been in contact with flood waters will allow a property to properly dry. This church in Ocracoke, NC, is shown here being dried out before the flood damage is repaired. In implementing a wet floodproofing strategy, it may be desirable to replace lower sections of the walls with removable panels if a previous flood has already damaged the historic wall finish materials beyond repair.

Case Study

Wet floodproofing is often combined with other adaptations. To learn about how a historic property used this treatment, refer to Case Study 4: Combined Flood Adaptations to Protect a Rhode Island Livery on page 139.



[69] Before filling the basement, the slab or floor must be perforated to allow drainage. All utilities at the basement level must be moved up to a higher floor or exterior elevated platform, roof, or other elevated location. The basement interior must be filled with sand, gravel, soil, and/or grout until level with the exterior grade. Flood vents must be added to allow water to flow under and through the building. *Graphic: Blank Space LLC for NPS*

FILL THE BASEMENT

One flood protection treatment measure for a historic building that will generally have minimal impact on its character is to fill in the basement. However, this method can only be used for a basement that is below ground level on all sides and of masonry construction. A walkout basement would not be a candidate for this adaptation treatment. An unintended consequence of this treatment is a basement can hold water during a flood event, and that water would be displaced if the basement is filled. Although filling a basement may have less impact on the historic character of a resource, it will result in the loss of space and/or access to any historically important features in the basement. If the basement contributes to the significance of the property or includes significant historic features, such as a kitchen space, dumbwaiter, or an innovative historic heating system, this treatment is generally not recommended.

Local ordinances may define basements in different ways. In some cases, a basement is considered occupied space that therefore needs to be protected from flooding. In other instances a basement is viewed as only unfinished space that can flood. A property owner will need to learn the specific rules in their community.

Fill material can be compacted gravel, soil, sand or grout and must reach the same level as the ground surrounding the building. In some cases the fill material will settle further and more material must be added to maintain the necessary fill height equal to the surrounding ground level.

Technical Limitations:

- The treatment can only be used on buildings with basements of masonry construction due to structural considerations.
- Access and clearance to the basement must be sufficient to allow compacting equipment to enter and to be removed after the basement has been filled.

(a) *Photo: Nick Balding/www.baldingbrothers.com*

(b) *Photo: Angie Edwards.*

[70] (a) A wood-paneled former game room remains in the basement of (b) this house in Wilmington, NC. This historic interior space contributes to the character of the property and should be carefully considered in reaching any decision to fill the basement.

STRUCTURAL CONSIDERATIONS

RECOMMENDED	NOT RECOMMENDED
Assessing the strength of basement walls and footings to ensure they are strong enough to support the fill after it is compacted.	Filling in a basement without assessing or evaluating the strength of the basement walls and footings to ensure they are strong enough to support the fill when compacted.
Modifying and anchoring basement walls and footings, when necessary, to provide enough strength to support the fill as long as the modifications do not significantly alter the visible exterior portions of the foundation.	Altering visible exterior foundation walls to an extent that the historic character of a building is negatively impacted.

(a) *Photo: New Leaf Redevelopment Consulting*

(b) *Photo: New Leaf Redevelopment Consulting*

[71] Utilitarian basements are ideal candidates for an infill treatment. Furnaces, hot water heaters, and similar mechanical equipment should be moved to a higher secondary space. This house in Cedar Rapids, IA, filled the unfinished masonry basement to create a small crawlspace. (a) Wood posts were replaced with concrete block piers. (b) The basement was filled until it was level with the exterior grade.

DRAINAGE

RECOMMENDED	NOT RECOMMENDED
Removing or breaking up a non-porous or concrete basement floor slab prior to adding fill or creating drainage holes and trenches in the existing floor. All foundations and footings should be identified and protected before beginning work.	Filling in a basement without addressing potential drainage issues that may arise as a result of the fill.
Installing a pumping system in an accessible location to drain the space if necessary.	Neglecting to install a pumping system if needed to facilitate drainage.

SYSTEMS RELOCATION

(SEE PROTECT UTILITIES)

RECOMMENDED	NOT RECOMMENDED
Relocating all systems and utilities currently within the basement, including HVAC, plumbing, and electrical, above the established flood risk level to a secondary interior space with minimal significance and visibility, such as an attic or closet.	Relocating systems and utilities to a historically-significant interior space or a highly-visible location.

FILLING THE BASEMENT

RECOMMENDED	NOT RECOMMENDED
Using a fill material, such as gravel, soil, or sand that could be removed in the future.	Using fill material such as concrete that will be difficult to remove in the future.
Compacting the fill so that it protects the basement adequately from water entering the space.	Leaving the fill material loose without compacting it.
Filling a basement to the required fill height which is equal to the surrounding ground level.	Adding insufficient fill material that is not enough to reach the required fill height.
Monitoring and supplementing the fill in place with additional fill if needed to maintain the required fill height.	

[72] Filling a basement requires access to bring the fill below grade and to maneuver compacting equipment in the space. In this example, a prior flood-damaged section of the foundation wall created an opening that allowed earthmoving equipment access to the basement. The exterior will be repaired once work is complete below grade. *Photo: Mitch Paine*

(a) *Photo: Northern Neck Planning District Commission*

(b) *Photo: Northern Neck Planning District Commission*

(c) *Photo: Northern Neck Planning District Commission*

[73] *The process of elevating a building:* This small house is shown (a) before, (b) during, and (c) after being raised and placed onto a new foundation. The building is raised on temporary steel beams and braced on cribbing as the concrete-block foundation is built below, before being set down upon the new foundation. The building will require additional design and landscape features to finish the foundation and mask some of the change in height.

ELEVATE THE BUILDING ON A NEW FOUNDATION

This adaptation method involves raising the height of a building by lifting the building from the existing foundation, constructing a higher foundation, and resetting the building on the new base. While this is one of the most common solutions for addressing flood risk, the historic character and appearance of the building can be considerably impacted when the change in height of the new foundation is significantly different from the original height. Elevating a building on a new foundation can greatly affect the historic character and integrity of the building, and any associated historic district, if not carefully planned and considered.

This adaptation treatment can generally protect a historic building from any type of flooding if the water does not reach the new first floor after elevation. The anticipated flood type will dictate the foundation treatment. For example, in a fast-moving flood a building that is properly tied to the piers of an open foundation will generally have less damage than a building on a closed foundation. In other circumstances, break-away walls may be the only type of solid infill allowable below the established flood risk level. Local zoning and building code requirements may limit how, and to what height, a building may be elevated.

Consultation with a local floodplain administrator or other knowledgeable professional will help identify requirements specific to a location or site. The local floodplain administrator may also be able to provide information about the future viability of community infrastructure impacted by flood events such as roads, sewers, and other utilities and services. Continued access to infrastructure should be considered; there could be a point in the future when an elevated building no longer has services or road access.

In general, this method of adaptation is easiest for frame buildings above crawlspaces, piers, or post foundations. Large masonry buildings, row houses, slab-on-grade construction, and downtown commercial buildings sharing party walls can be more challenging and expensive to elevate and, in some cases, impractical or infeasible. For example, in cases of multiple connected properties, like a block of row houses, close coordination and agreement among property owners would be necessary as well as shared financing and liability.

Buildings can generally be elevated a nominal amount without a major impact on the property's historic character. How high will depend on the historic character and appearance of the specific property. Thoughtful design will take into account both the flood risk and the existing historic design.

[74] Elevating masonry buildings built to the side lot lines can be difficult but has been done historically. This illustration shows an entire merchant block in Chicago being elevated at one time in 1857, as part of a larger plan to elevate the entire downtown area by four feet. *Photo: Chicago History Museum, ICHi-059709*

(a) *Photo: Rubion Construction Co., LLC*

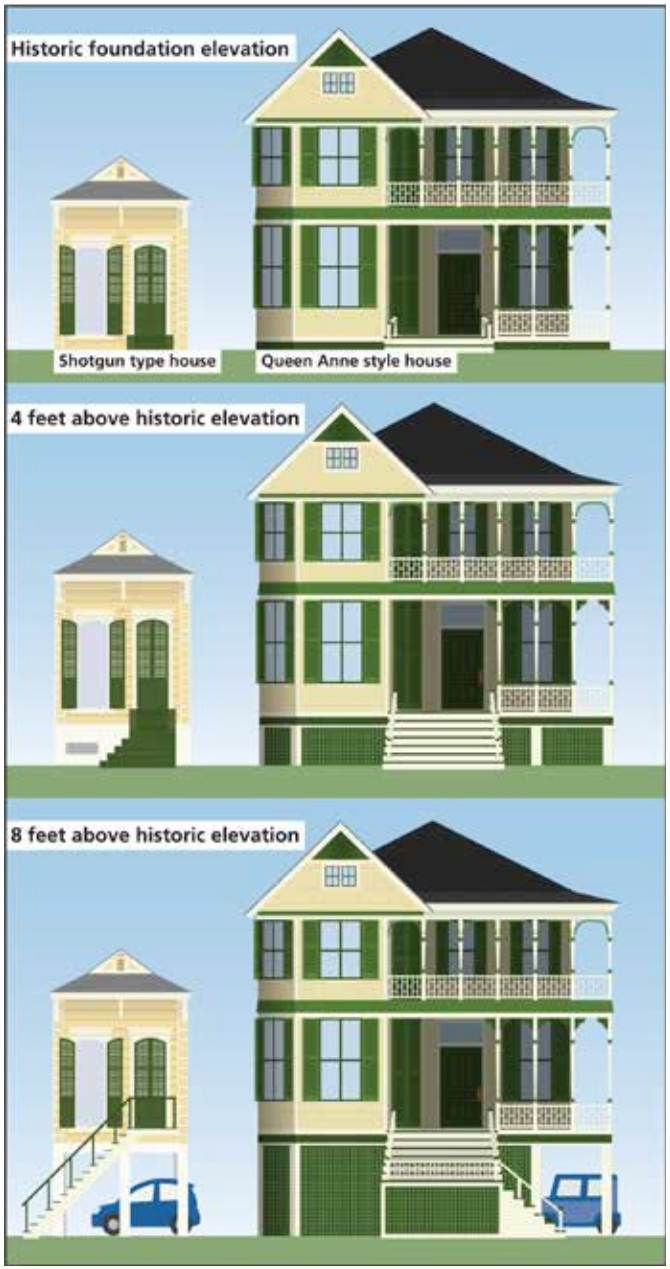
(b) *Photo: Rubion Construction Co., LLC*

[75] (a) It can be challenging to elevate ranch houses, which generally sit close to grade, more than a nominal amount without impacting their historic character and appearance. (b) This is probably as high as this house can be lifted and still maintain its historic character without significant site work to help disguise the change in elevation. The thin, dark-colored railings at the front porch and stairs visually recede.

The size, scale, height, and massing of a building will affect how much change in height may be acceptable without impacting the historic character of the property. **Establishing a universal standard or measurement for how high any given building can be elevated is not possible.** Generally, there is less perceived impact on the character of a historic building when the proportional and massing relationships of the foundation to the body of the building and the overall vertical or horizontal emphasis of the building are maintained. In order to maintain the overall historic character and appearance of the building, it is important to consider the following aspects of the site, setting, and design.

Property Considerations:

- topography and landscaping
- the shape and size of the lot
- placement and setbacks of the building on the site
- building footprint in relation to the shape and size of the lot
- massing and form including the existing overall width to height ratio
- building height and number of floors
- horizontal or vertical orientation
- property type
- construction type
- relative visibility of the foundation or basement
- mass of foundation in comparison to the main mass of the building



[76] Massing, scale, and proportions (tall vs. wide) are some of the important factors to consider when elevating a building and evaluating the impact on its historic character and appearance. *Graphic: Blank Space LLC for NPS*

(a) *Photo: Westfield Architects & Preservation Consultants*

(b) *Photo: Westfield Architects & Preservation Consultants*

[77] Elevating a building on a small site can require a change in access to the front door. In this example the main entry was retained, but the new stair had to be oriented to the side due to front setback requirements. The change in height has been masked with foundation plantings.

A smaller-scale building may be difficult to elevate more than a few feet without having an impact on its historic character. With some exceptions, elevating a small building to a height approaching a full story will not meet the Standards for Rehabilitation.

The historic setting, features, spaces, and materials of a building should be preserved if they are important in conveying the historic associations, character, and significance of the property. As the height of a building increases, meeting the Standards will be more challenging because of the substantial change to the character and appearance of foundations, basements, porches or terraces, and staircase height and length, as well as other exterior features and materials. For buildings within historic districts, elevations should be coordinated to maintain the historic spatial and architectural relationships among buildings and the character of the district. Local preservation guidelines can help provide standardized design and treatment approaches for elevating buildings specific to the district.

Where there is a tradition of elevating buildings, there may be more flexibility to increase the height of a foundation. In this historic context, a more significant degree of change may be acceptable while still maintaining the historic character of the property. Traditional adaptive approaches may be specific to certain regions, to building or construction types in those areas, and have common materials or design features. It is important to maintain the material and foundation treatments of the regional tradition.

Technical Limitations:

- The historic building must be structurally stable and/or repaired or temporarily reinforced in order to be raised onto a new foundation.
- There must be a structural system that can support the building on temporary cribbing while a new foundation is constructed. For example, buildings in which a structural slab also functions as the floor or subfloor do not have a platform that would support the walls when lifted.
- The building must be able to be physically separated from neighboring buildings, although attached buildings that are one structure can be elevated together.
- Constrained sites may control how high a building can be elevated due to limited space available to construct or extend stairs to provide access.
- Foundation type (open vs. closed) may be prescribed by the local ordinance.

[78] In many areas that have a history of flooding, buildings may have already been raised. Wheeling Island in the middle of the Ohio River in Wheeling, WV, was inundated by thirty-three floods between the 1860s and 1960s. During this period buildings on the island were constructed on tall foundations or were lifted onto higher foundations or berms after flood events. *Photo: Library of Congress, Prints & Photographs Division, photograph by Carol M. Highsmith (altered)*

[79] Buildings on a concrete slab can be more challenging to lift. In some cases, as shown in this example, the existing slab can be lifted and still remain the floor for the interior spaces. In other instances, the slab may need to remain at grade, with a new elevated floor structure constructed above. *Photo: p3elevation.com*

PLANNING AND PREPARATION

RECOMMENDED	NOT RECOMMENDED
Identifying, retaining, and preserving materials and features of the building that are important in defining its overall historic character before elevating the building.	
Assessing the impact of elevating a building on its historic character, including the aspects of the site, setting, and design of the property (see the Property Considerations list on page 76).	
	Elevating a building that was specifically designed to connect to or interact with the landscape without planning how to retain this spatial relationship, such as buildings with interior spaces that open onto a terrace or outdoor courtyard.

[80] A building cannot be easily elevated without impacting the historic character and appearance of the property when it has been designed to be closely connected to the landscape. For the David Cohen House in Siesta Key, FL, the architect Paul Rudolph designed the house to sit low to the ground and to have strong visual relationships to the exterior. Windows with large expanses of glass can be completely opened to the outside, bringing the outside in. Features such as flooring and wall materials continue from interior to exterior spaces. Elevating the building's spatial relationship to the surrounding landscape would not be a recommended treatment for this property.

(a) *Photo: Seibert Architects*

(b) *Photo: Seibert Architects*

Case Study

Elevating a building can be combined with other adaptations, particularly when it is not feasible or desirable to elevate substantially above grade. To learn about how several treatments were used in combination at a historic property, refer to Case Study 4: Combined Flood Adaptations to Protect a Rhode Island Livery on page 139.

PLANNING AND PREPARATION

RECOMMENDED	NOT RECOMMENDED
Documenting the building in photographs and/or graphics, particularly any features that may be lost or altered, prior to beginning work.	
Elevating later additions and porches that also contribute to the historic significance of the building along with the main structure.	Demolishing later additions and porches without regard to their historic significance.
Repairing any structural deficiencies, such as rotten sill plates and termite damage, before beginning work to separate the building from the existing foundation.	Lifting a building from its foundation without first conducting a thorough inspection and repairing any identified structural issues.
Protecting fragile features and materials subject to damage from minor movements or vibrations of the structure, like decorative plaster.	

[81] When planning to elevate a building, it is helpful to create mock-ups or visual representations to illustrate the new floor height in comparison to the existing height in order to evaluate the impact on the historic character of the building. In this example, the proposal is to elevate the building to 6 feet above the existing first-floor level. *Photo: Dianne Selditch/SoundWaters*

[82] Little can be done to mask or alter the appearance of a tall foundation. Once a building has been elevated the equivalent of a story or more, the overall proportions and scale of the building is often changed, resulting in diminished historic character. *Photo: Courtesy of the Southern Forest Products Association*

(a) *Photo: Rubion Construction Co., LLC*

[83] This historic house has been elevated and altered to an extent that it has lost its historic character and integrity. As part of the project to elevate the house, a new story was added beneath the original one-story building. Elevating a small-scale or one-story building by an additional story is almost always not an appropriate adaption.

(b) *Photo: Rubion Construction Co., LLC*

HEIGHT OF THE ELEVATION

RECOMMENDED	NOT RECOMMENDED
Identifying and retaining the historic massing, scale, size, form, and proportional relationships of the major elements of the historic building and/or the historic district.	Elevating a building without considering the impact to the massing, size, scale, form, and proportional relationships of the historic building and/or the historic district.
Designing a new foundation that preserves the historic character of the building.	Designing a new foundation that is too tall, so that its size and scale are out of proportion to the historic building and, diminishing its character.

(b) *Photo: Charles E. Leche*

(a) Photo: *Courtesy of* Preservation in Print *with permission of the photographer*

[84] This property in Mandeville, LA, is in an area of high flood risk and was elevated by an additional six feet. This necessitated a new stair and piers. In this case the original tapered porch columns were retained, and new brick piers were installed below. The new stairs are in their original location and orientation. The new porch balustrade emphasizes the porch level, while dark-colored lattice encloses a utility area below and helps to visually tie the building to the ground without it appearing like an additional story has been added to this one-story building.

(a) *Photo: Ward Wight Sotheby's International Realty via Pinterest*

(b) *Photo: Andrea Tingey/NJ Dept. of Environmental Protection, Historic Preservation Office*

[85] The Bay Head Yacht Club in Bay Head, NJ, was elevated after it was damaged by wave action from Superstorm Sandy in 2012. (a) The club building was constructed in 1928 on piers to allow easy access to the water, and the building sits entirely over Barnegat Bay. To lift the building eleven feet, 100 new concrete-filled steel pilings were driven 80-feet deep. (b) The change in elevation is less noticeable due to the massing, horizontal orientation, scale, and character of the building. As part of the project, missing historic architectural features, like the dormers, were reconstructed based on photographic documentation and physical evidence.

HEIGHT OF THE ELEVATION

RECOMMENDED	NOT RECOMMENDED
Using existing attributes and features such as large lot size, tall building height, visible foundation, porches or terraces, and stairs/steps to minimize the impact of alterations to the historic character of the property. For example, an existing porch can be altered to create a wider skirting board to mask a portion of the change in height.	Altering the building's important character-defining features to mask the change in height, such as elongating first-floor windows.
	Adding conjectural features from other buildings to mask a change in height, such as adding a new porch where none existed historically.
Applying historic regional or local traditions that have developed to adapt certain building types to flooding risks.	Applying regional or local traditions to property or construction types that are not associated with that location.
Elevating a building already on a visible historic foundation, such as a raised basement or crawlspace.	Elevating a building on grade or with no visible foundation more than a few feet without concealing or masking the change in height of the foundation using site alterations or other design techniques.
	Elevating a small-scale or one-story building to a height approaching a full additional story.

(a) *Photo: Courtesy of Ketchikan Museums: David Nicoll image, Tongass Historical Society Collection, THS 75.6.10.2*

(b) Photo: *Stephen Reeves*

[86] The Creek Street Historic District in Ketchikan, AK, is made up of "stilt" buildings, with piers or pilings as foundations. This type of construction is common in several parts of the U.S., including Alaska, the Puget Sound area of Washington, and other coastal areas around the country. Future flood adaptations in these places could use these local building traditions that evolved historically in response to flooding.

Case Study

To learn about how this treatment was used at a historic property, refer to Case Study 3: Elevating a House on the Mississippi Gulf Coast on page 135.

NEW FOUNDATION

RECOMMENDED	NOT RECOMMENDED
Constructing a new foundation that is compatible with the historic character of the building.	Constructing a new foundation that alters the overall proportions, massing, or scale of the building without making site alterations, such as regrading or adding elevated planting beds at the foundation, to minimize the appearance of the increased height.
Salvaging and reusing historic materials and features, like stone, brick, decorative vents, etc., from the historic foundation to construct the new foundation, particularly where visible.	Demolishing a historic foundation without saving salvageable materials for reuse.
Matching the new foundation to the visual characteristics of the historic foundation.	Designing a new foundation with a different architectural expression or appearance than the historic foundation.
Maintaining the visual appearance of piers or posts if a historically open foundation must be closed, such as using infill material that is recessed between piers and darker in color.	
	Selecting an open foundation for a building that historically had a closed crawlspace or basement without using design techniques to mask the change.

NEW FOUNDATION

RECOMMENDED	NOT RECOMMENDED
Using creative design techniques to minimize the perception of the change in height and appearance of the foundation of the historic building where compatible. Creating an illusion of solidity in tall open foundations by installing louvers or traditional lattice between piers or posts. Creating an illusion of a shorter foundation in wood-clad buildings by lowering the transition point from visible foundation materials to siding or weatherboard.	Designing new foundation treatments that mask the change in elevation to a point that alters the historic proportions of the building and changes its historic character.
Installing flood vents in solid foundation walls. Reusing historic foundation vents in highly visible locations where feasible. Selecting a compatible design and placement for new vents, or painting vents to blend with the foundation material.	Installing flood vents in a haphazard pattern or in locations that compete with the architectural rhythm or historic character of the building.

(a) *Photo: Courtesy of Julie Nucci and James Overhiser*

(b) *Photo: Courtesy of Julie Nucci and James Overhiser*

(c) *Photo: Courtesy of Julie Nucci and James Overhiser*

[87] This Greek Revival temple-front residence in Owego, NY, was flooded in 2011. The building sits close to the ground, with little visible foundation, and it was substantially elevated to reduce flood risk. In this case, the lot size, massing, and style of the property enabled it to be raised on a new plinth foundation. This compilation of images shows (a) the original location; (b) during the flood, which inundated the first floor; and (c) after the building was repaired and elevated to its new height. The treatments to visually minimize the new height include a new foundation with flood vents and a change in the new stair design and materials: stone at the first run of stairs, then wood above a landing, that breaks the stairs into two smaller runs. Plantings and new fill also help disguise the change in height.

(a) *Photo: Sean Clifford/NPS*

(b) *Photo: Tina Roach/NPS*

[88] (a) Lattice, louvers, or any other screening at the foundation should be located between piers (and generally recessed within the opening). (b) Lattice attached to the surface of posts or piers and without finished edges is generally not compatible with the character of traditional buildings.

[89] This building in Louisiana has been raised on piers, but the foundation piers are set back from the face of the building, do not line up with the porch posts, and are visually undersized. New foundation piers, posts, and columns should have a visual appearance that more closely matches traditional foundation placement, size, and materials, even if that requires wrapping more modern, slender steel members with a masonry veneer. *Photo: Roderick Scott*

NEW FOUNDATION

RECOMMENDED	NOT RECOMMENDED
Retaining a substantial visual connection of the building to the ground when using an open foundation type. Using piers, posts, or columns large enough in width or circumference to visually support the structure, with the number and placement of piers, posts, or columns similar to that of traditional building practices or style, even if the new technology structurally requires fewer supports.	Failing to retain a substantial visual connection of the building to the ground when constructing a new, higher foundation. Selecting piers, posts, or columns that are visually undersized. Recessing all foundation materials; failing to extend historic columns, piers, or pilasters to the ground; or selecting a color scheme that creates an effect of a floating or unsupported building.
Relocating all utilities above the established flood risk level or protecting them in place with a watertight or impermeable enclosure. (See Protect Utilities)	Relocating systems and utilities to a historically significant interior space or a highly visible location.
Concealing, insulating, and protecting utility connections and any ducts or pipes located underneath the building in an open foundation.	

[90] While the use of architectural screening is recommended, it should generally be divided by foundation piers that have a relationship to existing porch elements. In this case, there are too few visible piers, which creates a "floating" or disconnected visual effect. Those that can be seen are undersized relative to the building and gives the impression of inadequate support. *Photo: FEMA*

ACCESS

RECOMMENDED	NOT RECOMMENDED
Retaining the historic access locations and the approach or orientation to the building and its front or main entrance, where feasible. Keeping the physical features that identify the historic access points.	Abandoning historic primary entry points or significantly altering the path to a front or main entrance, when it can be avoided.
Matching new stairs, railings, or ramps with the style and features of the historic design; and salvaging and reusing historic features to the extent possible.	

(a) *Photo: Jennifer Parker/NPS*

(b) *Photo: Louisette Scott*

[91] Providing access can be a particularly challenging issue when elevating a property. (a) In this example, although there was enough room on the lot to maintain the original stair configuration on the front of the building, the stairs were instead located under the porch. In some historic homes this is a traditional way to gain access between porch floors, but it is rare for the primary entrance and should be avoided at the front of the building unless it was a historic configuration. (b) For a building with a smaller mass, a new monumental, double-run staircase like this can easily overwhelm the original building and change its historic character.

ACCESS

RECOMMENDED	NOT RECOMMENDED
Constructing railings with traditional proportions, or, if a taller rail is necessary to meet code, retaining a horizontal rail at the traditional railing height.	Noticeably altering the design and proportions of a historic railing, so that it changes the historic character of the feature.
Breaking up the run of stairs with a landing or changing the design or materials, where appropriate, when a long run of stairs is required because of the change in elevation. Minimizing the perceived change in height by altering the material in the lower section of the stairs where terraces, raised planters, or regrading is used. Consider using stone, brick, or another material that blends in with the landscape.	Installing a long run of stairs that changes the historic character of the building and its site and setting if it can be avoided.

[92] Matching new stairs with the style and features of the historic property is a recommended way to integrate the new foundation and access points. Concrete stairs with landscape planters referencing the new foundation material helps maintain a visual consistency. *Photo: p3elevation.com*

[93] This home has used elevated planting beds across the front of the house to bring the landscaping up higher and help screen the change in height. The stairs are stone, to blend in with the foundation and the planters, and a landing breaks up the long run of stairs at a point that aligns with the top of the planters. This provides a visual reference point for what was the original foundation height. The garage remains at grade level. *Photo: FloodSavvy.com*

(a) *Photo: Roderick Scott*

(b) *Photo: Courtesy of Preservation Long Island*

(c) *Photo: Roderick Scott*

[94] Providing access for people with impaired mobility is an important consideration as part of elevating a building. Ramps, lifts, and elevators have all been used successfully, but the placement and design of such new features should be compatible with the historic building. (a) It is best to run ramps along the side of the building rather than projecting in front of the building or located in the front yard. (b) A switchback ramp was constructed along a side elevation of a former lifesaving station in New York that is located on a constrained site between a public beach and a street. (c) This platform for a lift is located on a secondary elevation and detailed to blend with the historic railing of the porch.

ACCESS

RECOMMENDED	NOT RECOMMENDED
Providing access via an exterior elevator, lift, or ramp located and designed to be compatible with the historic character of the property. Floodproofing or locating the operating system of the elevator or lift above the established flood risk level.	
Minimizing the impact of ramps by installing them on secondary elevations when it does not compromise accessibility or by screening them with plantings on more visible locations.	Installing elevators, lifts, or incompatible ramps at a primary entrance or relocating primary entrances to secondary locations to provide access without assessing other options or locations.

(a) *Photo: Jeff Rosenberg/Mississippi Dept. of Archives and History*

(b) *Photo: Jeff Rosenberg/Mississippi Dept. of Archives and History*

[95] At this Rosenwald School in Mississippi, (a) ramp access has been created within the footprint of a wide porch. (b) Locating a ramp behind the porch columns allows the new feature to blend in more with the historic architecture.

ASSOCIATED SITE ALTERATIONS
(SEE ALSO SITE AND LANDSCAPE ADAPTATIONS)

RECOMMENDED	NOT RECOMMENDED
Altering the landscape by adding fill or constructing raised planters to reduce the amount of new foundation that is visible.	Altering a landscape, garden, or archeological site that has historic significance in its own right or that is integral to the significance of the site in conjunction with the building.
Designing new driveways, parking areas, or patios so that they are as unobtrusive as possible and are compatible with the historic character of the property and the district. Using permeable surfaces where possible.	Adding new site features in prominent locations where they negatively impact the historic character of the building site or result in the loss of historic landscape features or plant materials. Adding new driveways and curb cuts to facilitate parking underneath an elevated house.

(a) *Photo: Robert Joseph Glazar/Alabama SHPO*

(b) *Photo: Evolve Vacation Rentals*

(c) *Photo: Grant files/Alabama SHPO*

[96] Damaged by Hurricane Katrina, the Charles Marks house located along the Gulf Coast of Alabama used fill soils to camouflage the new foundation height on the water side while retaining the existing grade on the street side. (a) The original structure was supported by low, tapered concrete piers, approximately 18-inches high with an open crawlspace. (b) To bring this coastal structure into compliance with FEMA regulations, the house was elevated approximately 6.5 feet above its original height. (c) To mitigate the visual impact on the water-facing façade of the house, sand was used as fill on the site to raise the grade to within approximately 18 to 24 inches of the floor joists. The new grade gradually falls away toward the edges of the property. Retaining walls were necessary in some places to contain the sand.

(a) *Photo: Courtesy of the National Czech & Slovak Museum & Library, Cedar Rapids, Iowa*

(b) *Photo: Jennie Morton, Herringbone Freelance*

[97] Fill soils can help to reduce the visible foundation. The new elevated height of this building in Cedar Rapids, IA, has been disguised by retaining the historic full-width front stair, adding a new center stair extending to the sidewalk, and filling the front of the lot to gently slope the grade to cover the new foundation on either side of the stair.

[98] (a) This small Creole cottage was built in 1890. The house is located in a V-zone, an area designated by FEMA flood maps with a defined flood risk that includes additional hazards from waves. (b) After elevating the house, the new floor level is approximately thirteen feet above the surrounding grade. In addition to elevating the house, parking was created underneath the building, with a driveway placed directly in the center of the front yard. These changes emphasize the new elevated height of the building, impact its setting and appearance, and eliminate access to the front doors. These alterations significantly change the historic character of the building and do not meet the Standards.

(a) *Photo: Rubion Construction Co., LLC*

(b) Photo: Jennifer Parker/NPS

IN HISTORIC DISTRICTS

RECOMMENDED	NOT RECOMMENDED
Elevating buildings in historic districts that are similar in style and size to consistent heights if that is the character of the district while maintaining the historic spatial and architectural relationships between the buildings.	Elevating buildings in historic districts that are similar in style and size to different heights unless that is the historic character of the district.
Elevating buildings in districts with a tradition or history of elevating buildings.	

[99] Consideration should be given to the overall impact on the historic character and appearance of a district. A significantly different or random change in foundation height is inconsistent with the historic character of this district. *Photo: Jennifer Parker/NPS*

[100] Elevating the interior floor level above the established flood risk requires several building alterations, including constructing a new floor, elevating any utilities, and creating access to the new floor level. The original floor to ceiling height must be substantial enough to allow space for the new elevated first floor. *Graphic: Blank Space LLC for NPS*

ELEVATE THE INTERIOR STRUCTURE

This treatment involves removing the existing first- or ground-floor level and replacing it with a new floor plate at a level above the established flood risk level while the exterior structure remains virtually unchanged. This treatment is most suitable for buildings with large-volume first-floor spaces, such as Main Street commercial buildings. For historic buildings that are more challenging to elevate, such as attached row houses, raising the lowest interior floor out of the established flood risk level may be a good alternative to elevating the entire structure. The existing first floor must have a ceiling height tall enough to accommodate the change, preferably without needing to alter ceilings or upper floors. All systems that lie below the new first-floor elevation, such as electrical and plumbing, will also need to be relocated to reduce the potential for loss and damage due to flooding. In order to limit flood damage, existing basements, crawlspaces, and newly-created spaces beneath the new floor level will need to be filled to a level even with grade (see Fill the Basement), have automatic flood vents installed to allow water to flow through the non-inhabited area (see Wet Floodproofing), or be sealed to keep water out (see Dry Floodproofing).

The new floor height should generally be limited to a level below the sills of first-floor windows or storefronts. Alternatively, the new floor should be held back from exterior walls to reduce visibility of the alteration from the exterior. This treatment may require changes to ground-level access points of the building. If the change in floor height is fairly minimal, subtle exterior alterations may solve access issues, but, more commonly, the new floor height is accessed within the building by constructing an interior stair or ramp.

This treatment can have a significant impact on historic buildings with intact, character-defining first-floor spaces. Generally, the first floor contains many of the building's character-defining interior spaces, features, and materials. Depending on the historic integrity of the building before the adaptation begins, such changes can result in the loss of historic character.

Properties with a historically significant first-floor interior stair will require careful alterations to be able to retain the functionality and appearance of the stair. Every effort should always be made to retain the stair, if possible, and relocate existing decorative features and materials that would otherwise be impacted (i.e., wainscot, baseboards, etc.). Buildings with significantly altered interiors may generally be more suitable for this type of treatment.

Technical Limitations:

- Existing floor-to-ceiling height of the first floor must be tall enough to accommodate the change in floor level without impacting the ceiling or structure above.
- Additional technical limitations will depend on which treatment (dry or wet floodproofing) is selected for the space below the elevated first-floor structure. Please refer to those treatments.

PLANNING AND PREPARATION

RECOMMENDED	NOT RECOMMENDED
Identifying, retaining, and preserving materials and features of the building that are important in defining its overall historic character before elevating the interior structure of the building.	Elevating the interior structure in a manner that results in the destruction of the historic character of the building.
Documenting the building in photographs and/or graphics, particularly any features that may be lost or altered, prior to beginning work.	

STRUCTURAL CONSIDERATIONS

Several structural and technical considerations associated with this treatment must be carefully evaluated. These include assessing the walls, columns, and footings for structural capacity and potentially anchoring the building differently, depending on the existing connections. Refer to Fill the Basement, Wet Floodproofing or Dry Floodproofing, as applicable.

EXTERIOR CONSIDERATIONS

RECOMMENDED	NOT RECOMMENDED
Maintaining original entrances and fenestration patterns on the exterior of the building. Access to the new floor level from the original entrance level should generally be made on the interior of the building.	Altering the appearance of historic access points by lengthening or shortening original entries.
Maintaining storefront glass and bulkhead heights at their original locations.	Altering the appearance of the storefront by obscuring the original storefront windows or adding or extending the height of the bulkhead areas when elevating the interior floors.

(a) *Photo: Galveston Historical Foundation*

(b) *Photo: Galveston Historical Foundation*

[101] (a) The storefront doors of this commercial property have been floodproofed and the interior floor elevated. Unfortunately, the new floor resulted in a change to the storefront. The inappropriate change in appearance is apparent in comparison to the neighboring building. (b) The bottom of the storefront glass is now above shoulder level for an average-height adult pedestrian. This is not a recommended treatment.

(a) *Photo: The Roebuck, David Chance Photography*

[102] The first-floor level in this former warehouse building in Norfolk, VA, has been elevated, with a ground-floor lift installed to connect the lobby entrance with the new finished floor. The new interior floor level is held back from the primary entrance and is not visible from the exterior, minimizing the overall impact of the change. First-floor windows were high enough above the historic floor level that the new floorplate is below the windows where it meets the exterior wall.

(b) *Photo: The Roebuck, David Chance Photography*

EXTERIOR CONSIDERATIONS

RECOMMENDED	NOT RECOMMENDED
Retaining original windows on primary or highly visible facades, and protecting those windows that extend below the established flood risk level with temporary flood shields.	Removing or blocking historic windows on primary or highly visible facades with a new floor structure that abuts the windows.
Installing a new floor at a level below the sills of first-floor windows or storefronts, or holding back the new floor from exterior openings sufficient to minimize the visibility of the alteration.	Locating a new floor structure at a level above existing window sills or door thresholds, allowing it to be visible from the exterior or otherwise altering the building's historic character.
Preserving the historic character of the building if creating access to parking or storage underneath the new floor level. For example, adding a new exterior service entrance on the back of a building or other less visible location.	Putting in new storage or garage doors that alter the rhythm of the fenestration pattern, features, and appearance of the historic building.

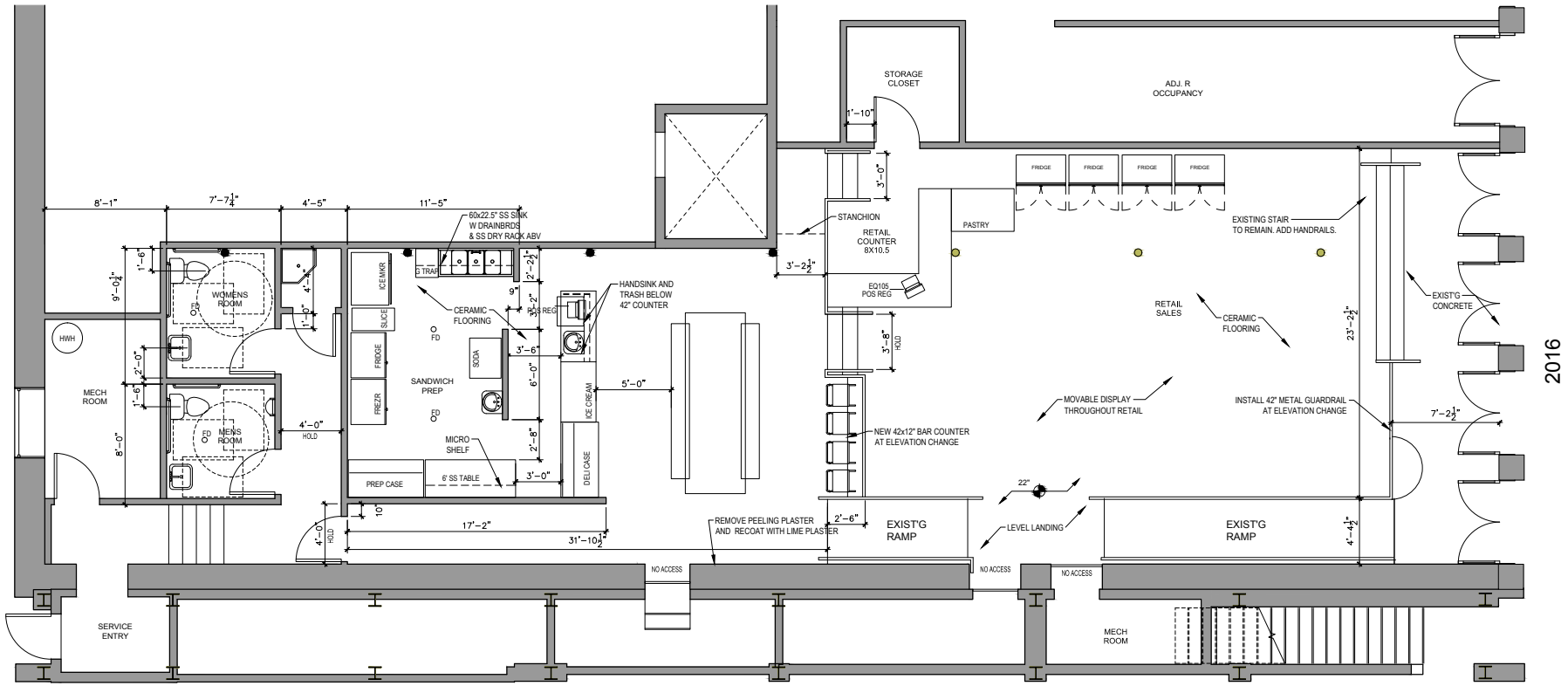
(a) *Photo: OPC Allan Investments LLC, Allan Development Company, and Allan Custom Homes, Inc.*

(b) *Photo: OPC Allan Investments LLC, Allan Development Company, and Allan Custom Homes, Inc.*

[103] This former grocery store in Cedar Rapids, IA, has a new interior floor constructed to be level with the sills of the storefront windows. This alteration does not change the exterior appearance of the historic storefront openings. The new floor extends outside to fill the corner recessed entrance, and new steps and a ramp were added to the side of the building. (a) Before the project began with storefronts boarded up. (b) After construction has been completed.

PLANNING AND PREPARATION

RECOMMENDED	NOT RECOMMENDED
Preserving character-defining spaces, features, and finishes when elevating the interior structure.	
Maintaining the historic character of entrances, while floodproofing the non-elevated access spaces.	Installing incompatible features and finishes to floodproof the non-elevated access spaces.
Adding interior ramps or stairs that are compatible with the historic character of the entrance while maintaining historic features such as lobby spaces or commercial storefront spaces.	Placing ramps or stairs in a location that disrupts the character and appearance of historic interior spaces and damages or removes historic interior materials and finishes.
Retaining historic materials and features such as original trim and reinstalling it at the new floor level.	Destroying historic features unnecessarily above the new elevated floor level.
	Destroying character-defining ceiling features and finishes if the new floor requires the ceiling to be elevated to maintain a useable floor height.
	Elevating the first-floor structure to a height that causes a 'domino effect' requiring removal and replacement of ceilings and floors above.

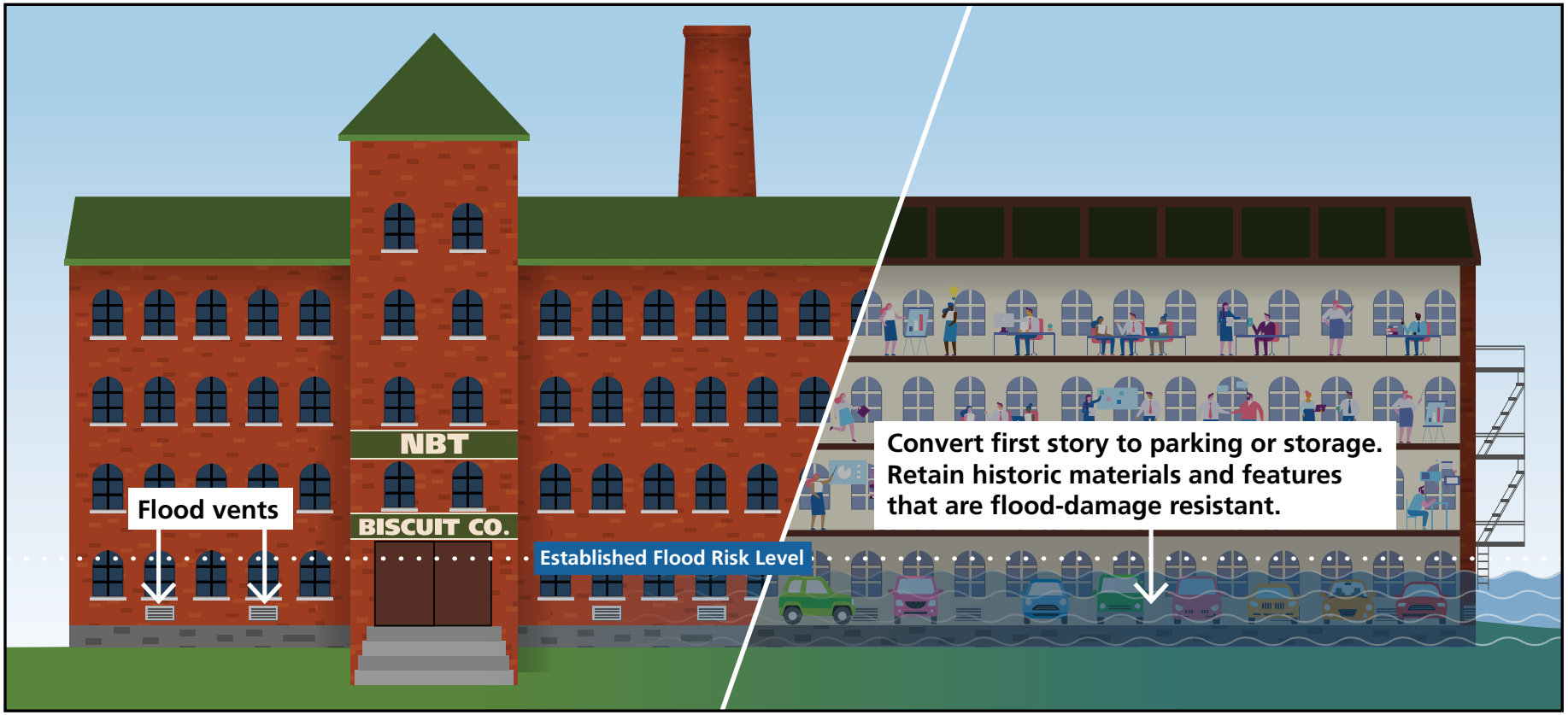


(a) *Drawing: Brax Easterwood, Architect, for Galveston Historical Foundation*

[104] The interior of this commercial space on The Strand in Galveston, TX, has a new floor placed seven feet back from the front of the building (railings have not yet been installed). This allows the street-level entrance to remain at grade, with new stairs and a ramp located within the building. The new floor has two levels, with building systems, bathrooms, and a preparation kitchen on the upper level for more protection from possible flooding. The new floor-to-ceiling height in the elevated interior is still high enough to maintain the original character of the commercial space.

(b) *Photo: Galveston Historical Foundation*

(c) *Photo: Galveston Historical Foundation*



[105] Abandoning the first story of a building to prevent damage from flooding must be combined with either dry or wet floodproofing. This graphic illustrates the wet floodproofing option. Occupied spaces are moved to the upper floors of the building, and the lowest floor is converted to parking, storage, and access spaces to the upper floors. Flood vents or openings are added or modified to allow water to flow in and out of the building. Durable historic features and finishes should be retained and replaced in kind if damaged or deteriorated. *Graphic: Blank Space LLC for NPS*

ABANDON THE LOWEST FLOOR

This adaptation method requires modifying a multi-story building to relocate all living spaces to floors above the established flood risk level. Any abandoned story below the established flood risk level must be altered and adapted into a utilitarian wet or dry floodproofed space. A local floodplain ordinance may determine which floodproofing method is allowable. This option is best suited for multi-story masonry buildings. Historic buildings with unfinished interior spaces that are constructed of durable materials, for example, mills or industrial buildings with load-bearing masonry walls, are likely candidates. This treatment is not recommended for light-frame construction. Due to concerns about life-safety and potential repetitive damage, this adaptation requires losing occupiable space within the building. After the project is complete, the abandoned floor may only be used for parking, storage, and building access.

The abandoned story can be dry or wet floodproofed (see Dry Floodproofing and Wet Floodproofing). Wet floodproofing is not recommended as a treatment for a building with a significant amount of historic integrity at the first story.

Abandoning the lowest story will also shift the location of the conditioned space within the building envelope. Such a shift may have unintended consequences for historic materials by changing the number of freeze-thaw cycles or the location of the dew point within a wall. It is important to consult a professional who can help model or predict such changes and how they might be addressed.

This treatment will result in the loss of usable floor area in the building, and owners may therefore decide to recover the lost floor area by adding to the building or making other alterations. New rooftop and other additions to historic buildings should follow the guidance in the Guidelines for Rehabilitating Historic Buildings.

Technical Limitations:

- The building must be at least two stories.
- This method cannot be used for light-frame buildings, as all walls in a flood zone must be made resistant to water damage.
- Additional technical limitations will depend on which treatment (dry or wet floodproofing) is selected for the abandoned floor. Please refer to those treatments.

PLANNING AND PREPARATION

RECOMMENDED	NOT RECOMMENDED
Evaluating the strength of walls, columns, and footings to ensure they are strong enough to withstand flooding and support the retrofit of abandoning the lowest floor of the building.	Abandoning the lowest floor without proper reinforcement of the lower levels to withstand flood forces.
Documenting the interior materials, features, finishes, and spaces on the first story prior to abandoning it.	

STRUCTURAL CONSIDERATIONS

Several structural issues associated with this treatment must be evaluated. These include assessing the walls, columns, and footings for structural capacity and potentially anchoring the building differently, depending on the existing connections. Refer to Fill the Basement, Wet Floodproofing or Dry Floodproofing, as applicable.

(a) *Preservation and Design Studio*

(b) *Preservation and Design Studio*

(c) *Preservation and Design Studio*

[106] This project in Texas included the conversion of former retail tenant spaces into parking as part of a larger rehabilitation. Although the conversion was not due to flood-related issues, the design principles are the same. (a) The character and transparency of the storefronts were maintained along the sidewalk. New partition walls create an interior display space and conceal the new parking area from view. (b) The altered interior retained no historic features or finishes prior to the project. (c) The space was opened up into a single parking area, and the walls and ceilings were finished to maintain the historic character. Vehicular access is provided on a secondary side elevation of the building, visible in photo (a).

EXTERIOR AND INTERIOR CONSIDERATIONS

RECOMMENDED	NOT RECOMMENDED
	Selecting wet floodproofing for the abandoned story if the interior spaces still retain a high level of historic materials, features, or finishes.
Retaining historic materials, features, and finishes that are flood-damage resistant. Removing non-historic finishes and furnishings that absorb and trap moisture, such as carpets.	Removing intact, undamaged, or repairable historic materials, features, and finishes in anticipation of a possible flood.
Maintaining and using existing access points (entrances, stairs, and elevator shafts) to gain access to upper floors.	Relocating interior access points (stairs and elevator shafts) so that the original circulation patterns and historic relationships between interior features and spaces are altered.
Keeping new interior stairs, elevators, or lifts within the first-story space away from windows or storefronts at the original first floor.	Inserting new interior stairs, elevators, or lifts that cut across the glazed areas of windows so that they are highly visible from the exterior.
Designing secondary egress from the new first story so that it is compatible with the historic character of the building and does not destroy historic materials.	Installing a means of secondary egress from the new first story without considering its impact on the historic character and appearance of the building.
Creating compatible new openings or altering existing openings, if necessary for new parking or storage areas in the abandoned story, on secondary elevations.	Creating new openings or altering existing openings for parking or storage uses on the primary facade(s).

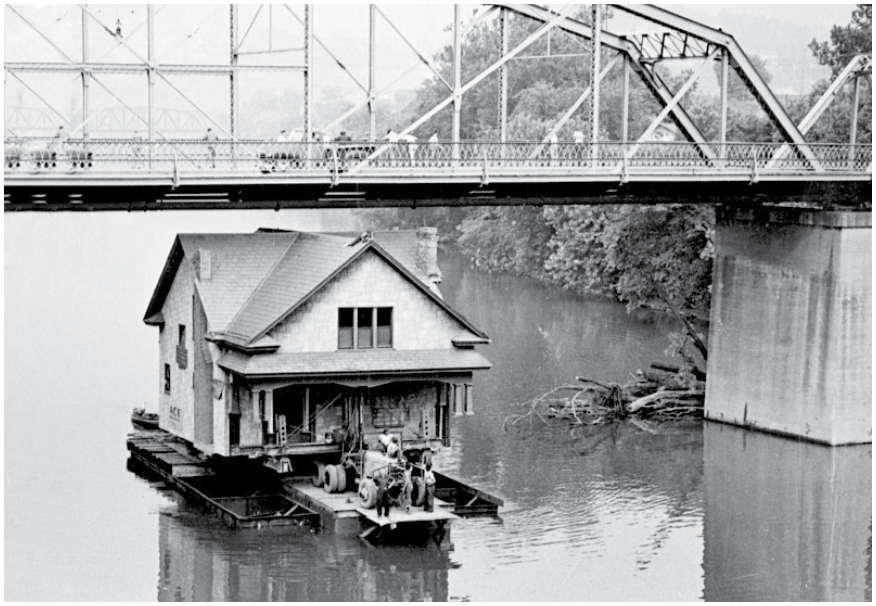
(a) *Courtesy of the Library of Virginia, illustration dated August 1871 from Ephraim Baker Records, Accession 50152.*

(b) *Jennifer Parker/NPS*

(c) *Jennifer Parker/NPS*

[107] (a) The former Green Furniture Factory in Alexandria, VA, was converted to apartments with parking on the first floor. (b) This project would not meet the Standards because the ground-floor openings were changed significantly and (c) a large rooftop addition was also added. Historic windows and doors on primary elevations should be retained and preserved even when the interior space becomes storage or parking.

[108] Some buildings were intentionally constructed to allow for relocation. For instance, many historic diners are similar in structure to early mobile homes. *Photo: Jim Paveglio, Geddes Building Movers, Inc.*



[109] At times, moving a house over water may provide more space to maneuver and facilitate keeping the building in one piece as it is moved. *Photo: Courtesy of mywvhome.com*

[110] In the past, buildings were moved considerable distances or around obstacles that may today seem insurmountable without modern heavy equipment and technology. This turn-of-the-twentieth-century postcard from Pittsburgh, PA, shows an extreme example, advertised as "the greatest house-moving feat ever accomplished." *Photo: Eichleay Engineering Corporation Records and Photographs, Detre Library & Archives, Heinz History Center*

MOVE THE HISTORIC BUILDING

Moving a historic building requires separating the building from its foundation and relocating it to a new site and foundation. Relocating a historic building is generally not a recommended preservation practice. In certain communities, however, there is a tradition of moving buildings. In some instances, whole neighborhoods and communities were relocated together. Moving a historic building is usually considered only when the property is expected to flood repeatedly, succumb to river or shoreline erosion, or is subject to permanent inundation due to sea level rise or subsidence. Moving a structure is more challenging, both technically and financially, when it is masonry construction, and it is not feasible for buildings with shared walls, like row houses, unless they are moved together.

The building must be strong enough to withstand the travel required in the relocation. Historic buildings that are in poor condition, or have structural deficiency or damage, may require additional reinforcement prior to a move. It is always preferable that a historic building be moved in one piece. In some cases, porches or small additions may need to be removed, relocated separately, and reattached to the building after relocation. The various construction periods, additions, and ancillary structures of a property should be considered in determining what needs to be moved to the new location.

Prior to the move, photographs of the building from all elevations should be taken, and interior finishes should be temporarily protected during the move (see NPS Tech Note 2: Temporary Protection). Graphics may be required if any sections of the building will need to be reassembled. (See HCRS Publication: Moving Historic Buildings).

The primary goal in selecting a new site should be a location that eliminates or reduces the flood risk. The new site should provide as similar a setting as possible to the original. In siting the historic building, consideration should be given to such factors as the original directional orientation of the building and if it had a strong visual relationship to a landscape or other feature, such as a road. The new foundation should match the original in height, design, and materials.

Moving a building to a new site requires a significant amount of preparation. Depending on the distance and the route to the new location, coordination with local highway departments, police departments, local permitting agencies, and utility companies may be required. If the building passes through more than one locality, each government entity may charge for permits, police assistance, etc.

State and Tribal Historic Preservation Offices (SHPO/THPO) play a vital role in determining whether the building's historic designation can be retained in a new location, as per Federal regulations (36 CFR Part 60). Properties may be delisted from the National Register of Historic Places if moved without prior review. Building owners should work with the SHPO or THPO prior to moving. Relocations that include Federal buildings, assistance, or permitting will involve the SHPO or THPO as part of the Section 106 review process prior to the move (see 36 CFR Part 60 and 36 CFR Part 800).

Technical Limitations:

- The building must be structurally stable to move safely or feasibly disassembled and reassembled on the new site.
- Masonry buildings can be more difficult to move.
- The new site must be located outside of the established flood risk area but similar in character to the original setting.
- Routes between the historic location and the new proposed site must be suitable for transporting a building.

(a) *Photo: Tricia Sandahl/City of Mason City, Iowa*

(b) *Photo: Jeff Heinz, The Globe Gazette*

(c) *Photo: Robin Anderson, Mason City Chamber of Commerce*

[111] In Mason City, IA, four historic houses were moved as a group from sites bordering the Winnebago River to a new location several blocks away. (a) The buildings were located in similar proximity to one another on their new sites. (b) One of the four houses that was relocated was the Egloff House, built in 1938 and seen here on the original site. (c) It was moved in two sections and located on the new site with an almost identical paved driveway, concrete patios, and sidewalks.

PLANNING AND PREPARATION

RECOMMENDED	NOT RECOMMENDED
Finding an available site with as similar a setting as possible to the original site of the building that also eliminates or reduces the flood risk.	Relocating a building to a site that is noticeably different from the original setting of the building if it can be avoided. Selecting a site that does not reduce the flood risk.
Documenting the historic building with photographs, a site plan with the four directional cardinal points noted, and the relationships to outbuildings and other site and landscape features noted.	Moving a historic building without documenting the existing conditions at the original site.
Hiring a professional building mover to undertake the move and ensuring that the move is adequately covered by cargo insurance for all phases of the relocation project. Special permits may be required from state or local governments and utility companies.	
Moving a historic building in one piece, without disassembling portions or sections of it, whenever feasible. Ensuring that disassembled sections or units of a historic building are clearly marked with each unit's orientation, i.e., front and back, individually numbered, and its location on the building marked on a plan and elevation graphics. Providing a secure location for storage of all disassembled components.	Losing or unintentionally damaging archeological data that may exist on the original and new site.

(a) *Photo: NPS*

(b) *Photo: NPS*

(c) *Photo: NPS*

(d) *Photo: Lydia Zepeda*

[112] The Ipsut Creek Patrol Cabin located in Washington state within Mount Rainier National Park was impacted by (a) significant flooding in 2006 that (b) resulted in a washout of the soils beneath the cabin. It was determined that the log cabin should be moved to a less flood-prone area. Prior to being relocated, the cabin was documented. (c) Each feature and building component were tagged and then carefully disassembled. (d) Finally, the building was reconstructed in a new location within the park with reduced risk for flooding.

MOVING CONSIDERATIONS

RECOMMENDED	NOT RECOMMENDED
Providing protection by bracing or covering fragile features and materials such as chimneys, stucco, interior plasterwork, windows, and decorative trim prior to the move.	
Retaining later features and additions to a building that contribute to the historic character when moving a structure. Moving outbuildings important to the historic character of the property to the new site.	Removing later additions for the move that may have acquired significance. Moving only the main building when there are outbuildings and other features that are important in defining the historic significance of the property.
Ensuring the moved building will have no negative effects on neighboring properties in the new location and will not diminish their integrity of setting.	

[113] Fragile features like chimneys should be evaluated and braced before a building is moved. *Photo: Mike Booher/NPS*

RELOCATION

RECOMMENDED	NOT RECOMMENDED
Constructing a foundation that is structurally adequate to support the historic building and obtaining the necessary permits prior to relocating the building.	Constructing a new foundation that is structurally inadequate. Altering the building to provide additional living or storage space under the building without masking the additional foundation height.
Retaining the historic relationship between buildings and the landscape.	Placing the historic building in the new location without consideration of the orientation, setting, or environment of the original historic site, diminishing its historic character.
Making appropriate repairs to sill plates and floor joists while the building is on temporary cribbing and these features are accessible and visible.	
Allowing adequate time for the historic building to settle on the new foundation before repairing finishes or chimney features.	
Placing historic outbuildings at the new site in the proper location and distance from the main building based on documentation.	Placing outbuildings and other important features on the new site without regard to their original use, locational relationship, or distance from the main historic building.

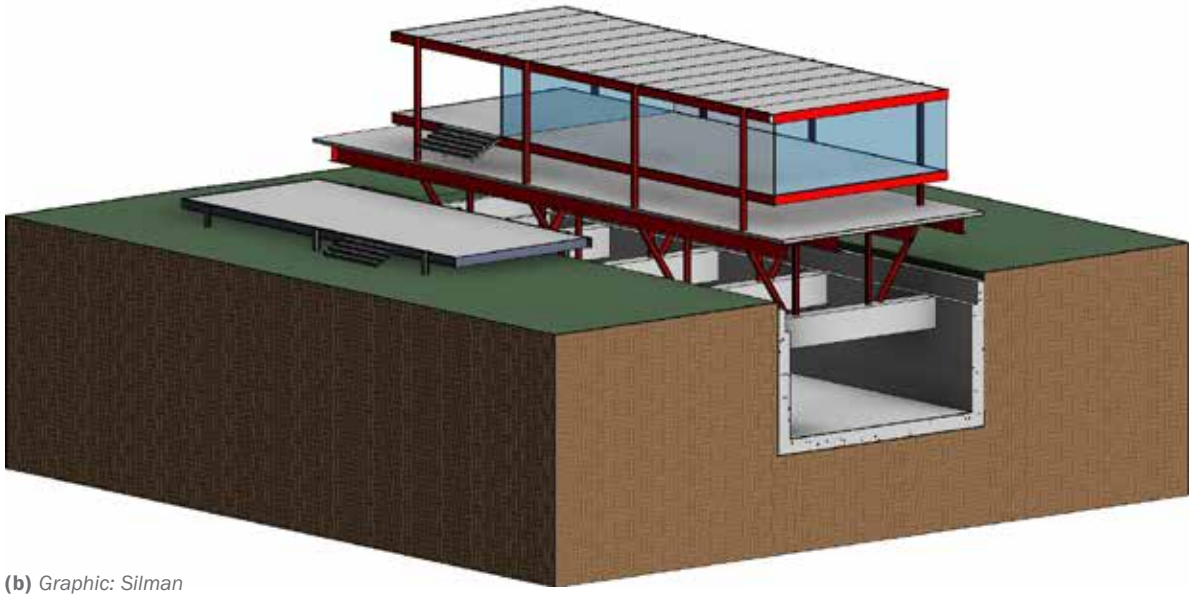
(a) *Photo: U.S. Coast Guard*

[114] (a) The Cape Hatteras Lighthouse, Principal Keeper's Quarters, and Double Keeper's Quarters located in North Carolina were moved inland in 1999 to save the structures from the encroaching sea. (b) At the new site the three structures were located the same distance and orientation to one another, preserving significant spatial characteristics and relationships of the complex.

(b) *Photo: Courtesy of Outer Banks Visitors Bureau*

(a) *Photo: Mike Crews Photography*

[115] (a) The Mies van der Rohe-designed Farnsworth House in Plano, IL, near the Fox River has regularly experienced flooding events since it was constructed in 1951. One method of flood protection under consideration for the house is to integrate a hydraulic system into the building's foundation. (b) The hydraulic lifts would be located in a concrete pit below the house and attached to its concrete slab/ foundation. During a flooding event, the hydraulic lifts move the house and slab above the flood level and return it to its original elevation after flood waters recede.



(b) *Graphic: Silman*

UNCONVENTIONAL ADAPTATIONS AND INNOVATIVE TECHNIQUES

There are a number of potential treatments in the developmental or experimental phase for adapting historic properties for flood risk. Some are in the prototype phase for retrofitting historic properties and are being tested for their performance and include:

- Hydraulic lift and anchoring systems to allow a building to remain at existing foundation height and be lifted above the flood risk level during a flooding event.
- Buoyant foundations with guideposts, also known as "amphibious architecture," to allow a building to float. Buildings are retrofitted with buoyancy blocks, vertical guideposts, and a structural sub-frame.

Innovative large-scale site and landscape flood protection adaptations are also being undertaken at the community level to protect historic buildings, districts, landscapes, and entire neighborhoods. In addition to the treatments in the Site and Landscape Adaptations section, which are focused primarily on treatments that can be applied to a single historic site, large-scale flood protection infrastructure projects generally involve many stakeholders, require significant resources and funding, and include:

- Mechanized sea walls that can be constructed as large-scale protection. For example, the MOSE flood protection system in Venice, Italy, begun in 2003, is being constructed in phases.

(a) *Photo: E. C. English, renders b Project*

(b) *Photo: E. C. English, renders by the Buoyant Foundation Proiect*

(c) *Graphic: Buoyant Foundation Project*

[116] (a) Properties with smaller, symmetrical footprints such as these shotgun houses are potential candidates for exploring a "buoyant foundation" approach to flood mitigation. (b) A buoyant or amphibious foundation allows a building to float during a flood event. (c) This system consists of the following primary components: buoyancy blocks that are placed under the building to allow it to float; vertical guideposts that keep the building centered above the foundation as it floats and are aligned to reconnect it with the foundation; a structural frame that ties the system together; and utilities that can either seal and break away or have long connections that can uncoil.

(a) *Photo: Courtesy of the City of Frederick: Department of Economic Development*

(b) *Photo: Courtesy of the City of Frederick: Department of Economic Development*

(c) *Photo: Jennifer Wellock/NPS*

[117] Frederick, MD, suffered severe flooding events and is among numerous communities exploring better ways to live with and manage, retain, and move water at a large community scale. This phased flood-control project improves an existing creek and surrounding public spaces. The creek's capacity to carry water is significantly increased via a system of underground conduits that move flood waters through the city at a more controlled rate. (a) This section drawing shows the four conduits with a city bus for scale. (b) Baker Park at the west end of the improvement area is designed to flood next to the choke point where water enters the conduits. (c) The creek improvements create a community gathering place downtown with events, art installations, and inviting paths to walk.

- Re-engineered existing flood protection systems and reestablished natural systems that protect larger areas and landscapes. Flood protection in the modern era has primarily relied on hardened protective systems like dams and levees designed to keep water out of a particular area. There is a growing interest in reestablishing or redesigning natural water drainage systems and removing such hard-engineered solutions and replacing them with more soft-engineered flood protection strategies. Activities may include widening previously controlled river channels, reestablishing canals, and designing other large-scale water retention areas. Projects may also reestablish coastal barriers and riverbanks with ecological solutions like shellfish reefs, native plantings, and living shorelines that reduce erosion and buffer flood effects like waves, inundation, and tides.

As these technologies become more widely used, the potential benefits and consequences to historic properties will need to be evaluated.

(a) *Brett Duke, NOLA.com* | The Times-Picayune, *1/27/2018.* The Times-Picayune/The Advocate

(b) *Photo: Avery Island Archives*

[118] Avery Island, LA, listed in the National Register of Historic Places and the historic home of Tabasco brand pepper sauce, has engaged in a program of reclaiming marshlands largely lost to manmade canal systems, erosion, and subsidence. By "canal plugging," using marsh vegetation like cordgrass, the Island has been able to protect and reestablish marsh lands and create a more sustainable and protected shoreline.

(a) *Map: Union County, PA, GIS Department*

[120] If a property is demolished, carefully salvaging historic materials can help other historic properties undergoing rehabilitation and give a 'second life' to these otherwise lost materials. *Photo: Jenifer Eggleston/NPS*

(b) *Photo: Pennsylvania State Historic Preservation Office, September 26, 2018.*

[119] Often "buyout zones" are identified in a community to purchase and remove properties to eliminate continued risk of flooding. (a) One such example is in Lewisburg, PA, where repetitive flooding events resulted in the creation of a "buyout zone" to demolish repeatedly damaged properties along a tributary to the West Branch Susquehanna River. (b) The use of the land after removal is restricted to permanent open space.

DEMOLITION

In this section demolition refers to the complete removal of a historic building and any related structures in order to clear a historic site within an established flood risk area. It is important to understand that **demolition is not a treatment that meets the Standards for Rehabilitation (or any of the Standards for the Treatment of Historic Properties.)**

This action may be incentivized where property buyouts have been identified as part of the community mitigation plan. In these and possibly other situations, a government agency may purchase a property and demolish the structure to eliminate continued property risk and allow for open space. In other cases, private property owners may choose to demolish an existing historic building in order to eliminate their flood risk, allowing them to rebuild in a more flood-resilient method or relocate.

The Standards were created to support the preservation of historic buildings. Demolition is never a recommended treatment. However, in making land-use and planning decisions for a community or neighborhood, there may be situations when it is necessary to identify sacrificial historic sites or structures. Demolition could be chosen to remove buildings most at risk, in order to provide space needed to undertake adaptive measures to protect other, more important historic buildings, or to allow for new structures designed to withstand water damage in future flood events. Such a decision should be made after research of the historic property or district has been completed, in order to fully understand the significance of the building(s) that would be lost and identify the risk reduction that would result.

Preservations Considerations

- Evaluating and considering all feasible alternatives before deciding to demolish any historic structure, such as adapting the property to flood risks, donating or selling the building, or moving it out of the established flood risk area.
- Documenting the building in photographs and/or graphics or 3-D scans prior to demolition.
- Ensuring that archeological resources are identified and protected prior to allowing heavy equipment into the area.
- Protecting neighboring properties from damage during demolition.
- Salvaging historic materials prior to demolition for reuse.

(a) *Photo: Sean Clifford/NPS*

(b) *Photo: Sean Clifford/NPS*

[121] This storm-battered historic cottage on the Gulf Coast displayed a clear statement to not demolish the building post-Hurricane Katrina. Many properties are lost to demolition after damaging storm and flooding events. Adapting these buildings to be more resilient to flood risks will help preserve and protect them from such loss.

CASE STUDY 1: DRY FLOODPROOFING A WISCONSIN MAIN STREET BUILDING

DRIVER OPERA HOUSE, DARLINGTON, WISCONSIN

Figure 1: This 1993 flood was one of several events that led to the listing of the Main Street Historic District in the National Register. *Photo: Lafayette County Historical Society*

Darlington is a small town in Wisconsin with a population around 2,400 people located in the southwestern area of the state. The town developed on the banks of the Pecatonica River and has flooded frequently throughout its history.

A series of devastating floods in the early 1990s instigated several flood mitigation projects. These efforts led to recognition of the importance of the town's history by completing a nomination of the Main Street Historic District for listing in the National Register of Historic Places. The district was listed in 1994 and includes the Driver Opera House as "one of the most unusual buildings in Darlington."

The Driver Opera House was constructed in 1883 of Milwaukee Cream City brick with polychrome brick accents. It was designed with ground-floor commercial spaces and a multi-functional assembly space on the upper floor. Plays, concerts, dances, and other entertainment took place in the building until the 1950s.

A community organization was formed in 2007 to raise funds to operate and renovate the building. The first phase of the rehabilitation project was to protect the property from future flooding by dry floodproofing the building, and the second phase will focus on rehabilitating the upper-floor assembly space which retains a historic stage and various architectural features.

The dry floodproofing project included several elements to adequately strengthen and prepare the structure for future flooding. The crawlspace was filled and fitted with a drainage system that relieves some of the external pressures on foundation walls and redirects water that seeps through doors and floodgates. Utilities were relocated to a secondary space above the established flood risk level.

Existing masonry walls were repaired and reinforced from the interior by the addition of a new concrete slab and knee walls (shown in green in Figure 2.) The 18-inch slab not only provides additional strength but also acts as ballast and works with anchor ties to prevent the building from floating off its foundation.

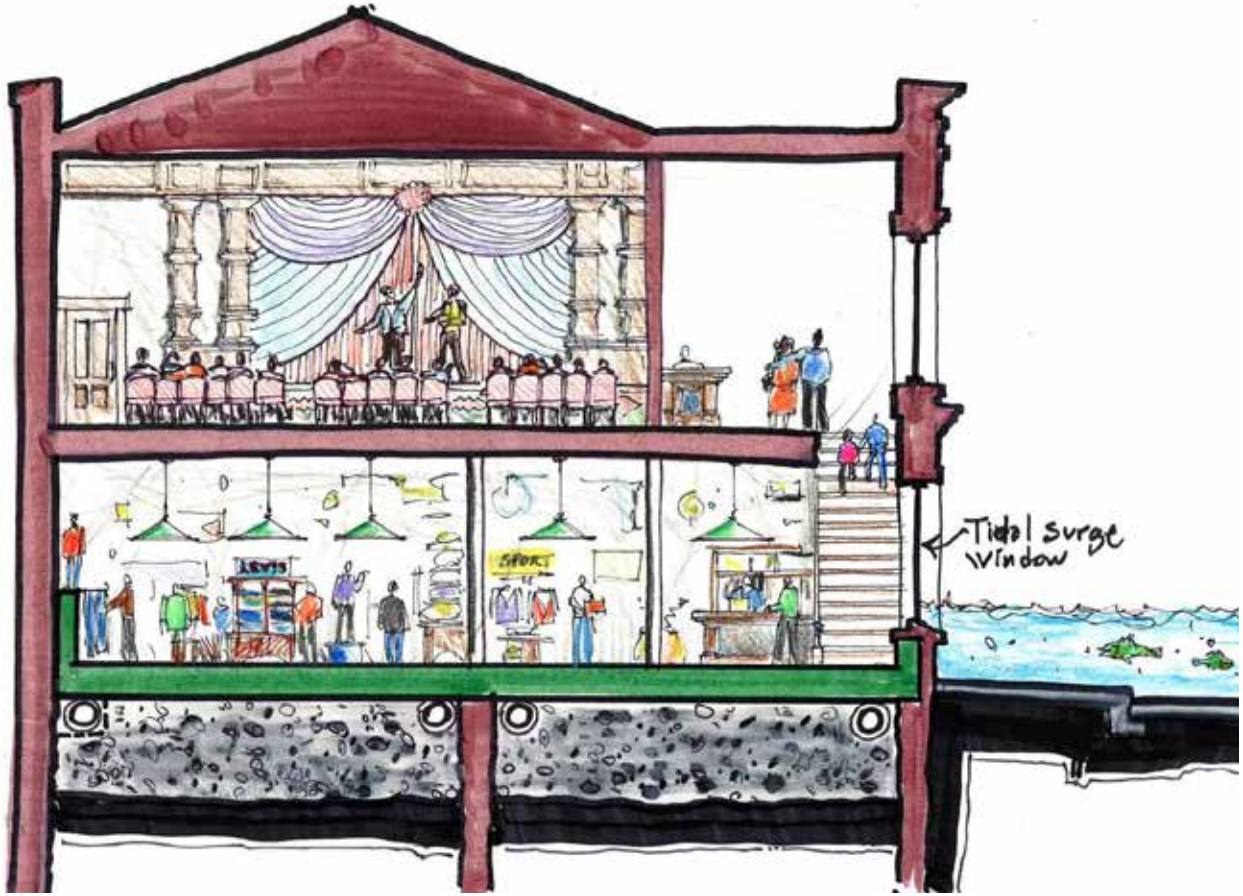


Figure 2: Concept drawing showing proposed alterations to the Driver Opera House for dry floodproofing. Ultimately the storefronts were protected by a two-stage barrier, as shown in Figure 4. *Graphic: KONTEXT architects llc*

Figure 3: The historic storefronts and brick bulkhead were extant before floodproofing work began on the Driver Opera House. *Photo: KONTEXT architects llc*

Above grade, the storefronts were largely reconstructed to repair and improve the historic design to be stronger and more flood resilient. The new waterproof barrier consists of a two-part system with a lower level of protection that aligns with the historic storefront sill, and a taller, code-compliant interior barrier is inset from the storefront by approximately 18 inches (see Figure 4). The shorter concrete knee wall provides stronger backup for flood-related impacts to the historic brick storefront bulkhead. Existing steel columns are anchored to the new concrete foundation and the second-floor structure. With the exception of the glass, the storefront framing and features are also anchored and engineered to resist flood-born debris impacts and hydrostatic forces. All of the materials to the exterior of the tallest flood barrier are waterproof and decay resistant.

The dry floodproofing measures were completed before Darlington flooded again in March 2019, an event described by local media as the worst flood since 1993. The architects of the project sought information about how the building performed.

"We are delighted to report that the Driver Opera House came through the floods with flying colors! The river reached 4" above the door thresholds on Main Street, and 5" above the door thresholds on Ann Street. All floodproofing systems worked exactly as designed – the floodgates seeped some water as expected, the trench drains inside the doors caught all of it, and the sump pump immediately sent it back out. No other water, and no messes to clean up – for the first time in living memory." – Board of the Driver Opera House Center for the Arts

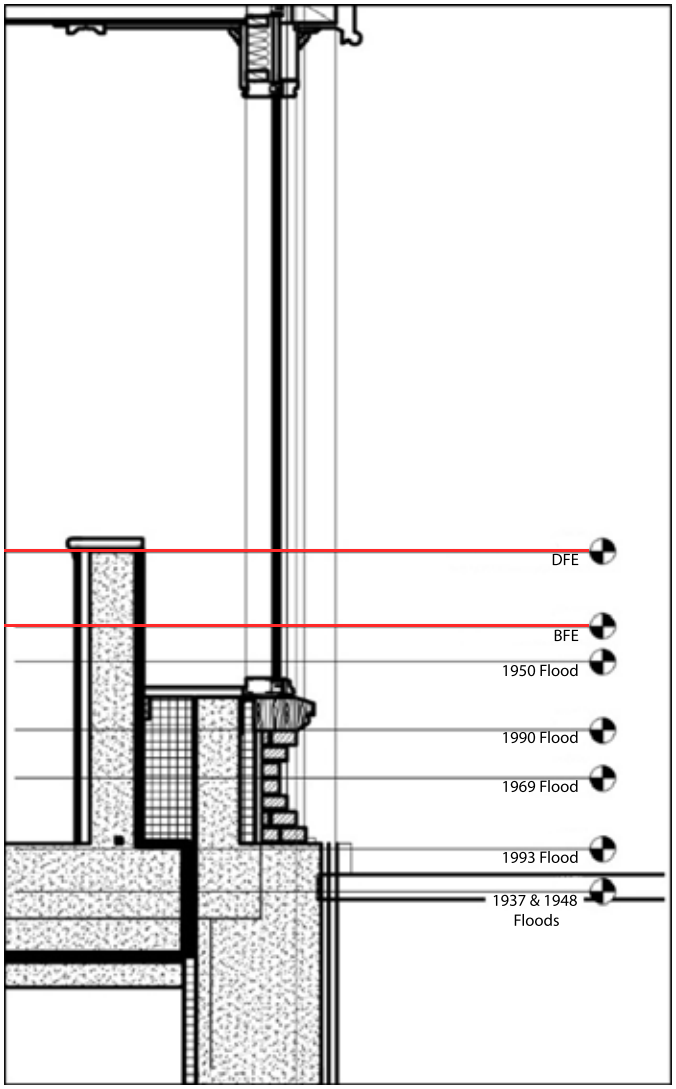


Figure 4: Section graphic of two-stage barrier at storefronts. Labels (from top to bottom) show the design flood elevation (DFE), base flood elevation (BFE), and various past flood events. *Drawing: KONTEXT architects llc*

Figure 5: Door jambs were designed with integral anchors for attaching removable floodgates. The anchors are visible but painted to blend in. *Photo: Heidi Brenum*

Figure 6: Exterior of the building after the dry floodproofing project is complete. The exterior steel storefront framing is a historic feature, painted green above the storefront and cream below after rehabilitation. *Photo: Dave Kettering/Telegraph Herald*

Figure 7: Floodproofing measures kept the water out of the Driver Opera House during a 2019 flood. *Photo: Brian Mesmer*

CASE STUDY 2: WET FLOODPROOFING A NEW JERSEY COTTAGE

METHODIST CAMP COTTAGE, OCEAN CITY, NEW JERSEY

Figure 1: View of the cottage from the street prior to Hurricane Sandy in 2012. No significant, visible exterior alterations were undertaken as part of the project to wet floodproof the house as part of the storm recovery. *Photo: Mary Delaney Krugman, JD, MSHP*

This cottage is one of twenty-two original "wooden tents" constructed as part of an 1885 Methodist camp meeting site. In the first decade of the twentieth century, these structures were sold and relocated to new sites including this cottage that was moved to its present location around 1905.

Wet floodproofing is generally most suitable for buildings or areas of buildings that are not occupied. Under some circumstances, property owners may decide that this strategy works well for an occupied structure such as this cottage that serves as a second home in Ocean City, NJ.

Mary Delaney Krugman, a professional historic preservation consultant, purchased the property in 2002 and began undertaking small projects to remove later alterations; uncover historic features and finishes; and address some flood resiliency needs. When Hurricane Sandy hit Ocean City in 2012, the deteriorated dining room floor had been replaced with a mahogany floor designed specifically to withstand flooding. A new addition had been constructed at the rear of the house and was elevated four feet above the main first-floor level to comply with floodplain requirements for new construction. The new addition contains all of the appliances and building systems for the house. These flood-resilient measures performed well during the storm that inundated the main level of the cottage with eighteen inches of flood water. The historic living and dining rooms that had neither been fully renovated nor elevated sustained considerable damage.

In the aftermath of Hurricane Sandy, layers of wall finishes were removed to allow the building to dry out and prevent mold growth. Most of the layers were non-historic later alterations susceptible to water absorption and mold growth. Very little material was salvageable.

Krugman had previously made the decision that elevating the historic cottage would not be the appropriate solution for the property. The relationship of the cottage to the landscape is a character-defining feature of the "wooden tent" that was important to preserve. Because she did not want to experience a similar post-flood clean-up and repair process in the future, Krugman decided to apply a wet floodproofing approach to her renovation and repairs.

The living room floor was structurally insufficient, and the entire house lacked anchoring between the frame structure and the foundation. A concrete structural slab was constructed under the living room. Hurricane ties were added to secure the frame house to the foundation, and the new living room floor was constructed to match the dining room floor that successfully survived Hurricane Sandy. The floor includes marine-grade materials and a gap between the subfloor and finish floor to allow air circulation and drying after a flood.

Walls were finished with flood-damage resistant cement wall board and closed cell insulation panels. A space was provided on the exterior wall for air circulation within the wall cavities. The baseboard and crown molding included slots and removable trim pieces to open the walls at the top and bottom, allowing air to circulate so as to dry out the wall cavities post-flood. The slots are filled with an insulating foam strip behind removable trim pieces. The foam insulation is removed immediately after a flood event.

Figure 2: In-progress repairs after Hurricane Sandy. Walls are open to the interior for initial drying. A new concrete structural slab has been topped with treated wood sleepers in preparation for a new flood-damage resistant mahogany floor. *Photo: Mary Delaney Krugman, JD, MSHP*

Krugman considered her furniture choices as she completed the project. Most contents can be relocated to the second story or elevated rear addition before a predicted flood event. However, large pieces of furniture like sofas are not easily relocated. To solve this problem, Krugman purchased lighter-weight furniture and devised a block-and-tackle system attached to hooks in the ceiling that allows the living-room sofas to be lifted above an inundation event.

All of these changes result in a property that maintains the historic character and features of interior spaces and can perform well during the next flood. Clean-up will be necessary, but there should be relatively few significant repairs required before the home is functional again.

Figure 4: Crown molding covers an opening at the top of walls to allow air to circulate and dry wall cavities after a flood, seen here before the sacrificial insulating foam strip has been applied. *Photo: Mary Delaney Krugman, JD, MSHP*

Figure 3: Instead of solid wall material, an open lattice was installed under the stair to vent an otherwise inaccessible space. *Photo: Mary Delaney Krugman, JD, MSHP*

Figure 5: Mahogany wood floor and baseboard with a gap at the base for future venting. Foam insulation strip fills the gap and will be covered with removable trim. *Photo: Mary Delaney Krugman, JD, MSHP*

Figure 6: The living room before Hurricane Sandy included non-historic wall and floor finishes. Windows and doors were also non-historic and made of materials that absorbed floodwater, warped, and/or could not easily be cleaned. *Photo: Mary Delaney Krugman, JD, MSHP*

Figure 7: After repairs and wet floodproofing measures have been implemented, the new floor and wall surfaces are flood-damage resistant. The front door and windows were also replaced with more compatible designs using flood-damage resistant materials *Photo: Mary Delaney Krugman, JD, MSHP*

Figure 8: A pulley system lifts heavy or bulky furniture above predicted flood waters. All other contents can be moved to upper levels of the house. *Photo: Mary Delaney Krugman, JD, MSHP*

CASE STUDY 3: ELEVATING A HOUSE ON THE MISSISSIPPI GULF COAST

HONOR-ATTAYA COTTAGE, OCEAN SPRINGS, MISSISSIPPI

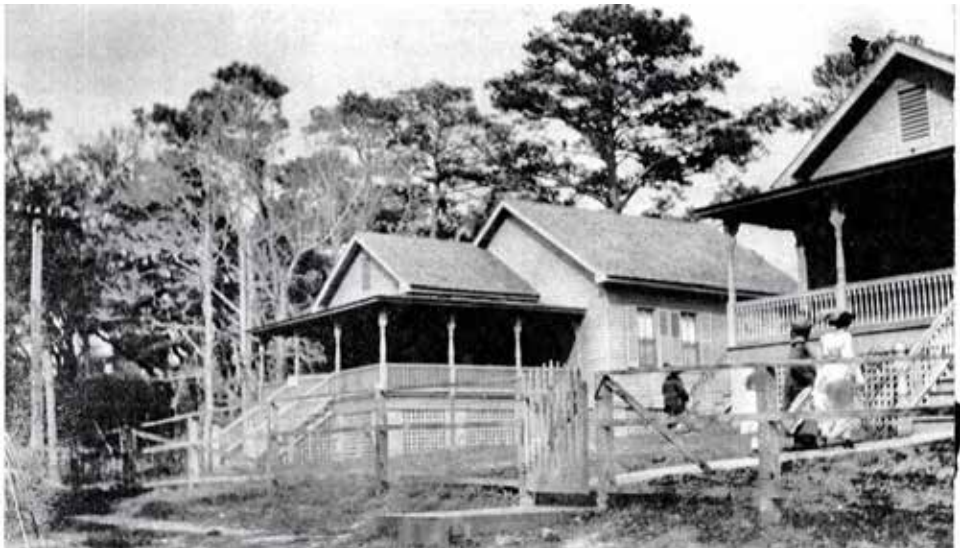


Figure 1: A Queen Anne house (center) on its original site facing Biloxi Bay before 1918. *Photo: Robert and Willene Dunnaway Friar/Courtesy of Ocean Springs Archives*

Elevating a building is one of the most common choices for flood adaptation, particularly for single-family residences in flood-prone areas. In coastal regions subject to hurricanes and tropical storms, elevating buildings is often a traditional method to adapt them to withstand such events.

This one-story Queen Anne-style cottage (See Figure 1) was constructed circa 1890 on a lot facing Biloxi Bay in Ocean Springs, Mississippi. With little natural protection from hurricanes, the original builders constructed the house and its neighbor on tall, open-pier foundations with lattice screening between the piers. The houses were also sited on the top of a small rise in an attempt to keep the interiors above any potential storm surge. Constructing houses on such tall foundations was historically—and remains—common practice in the Gulf Coast region. By 1918 both houses had been moved to make way for the construction of a larger house on the beach-front lot. The Queen Anne house was relocated a short distance to a new, and slightly higher, site on the same block, approximately 500 feet farther from the bay. Comparing photographs (See Figures 1 and 2), the foundation constructed at the new site appears to have been shorter in height than the original.

In the 1980s the house was listed as a contributing resource within the Old Ocean Springs Historic District. It was

severely damaged in 2005 by Hurricane Katrina which caused massive damage to many properties along the Gulf Coast. The storm completely destroyed and washed away the L-shaped front porch, part of the roof was stripped away, and the pier foundation was swept out from under the house. When the storm surge receded, the house was left sitting directly on the ground.

As part of the hurricane recovery efforts and to increase future storm resiliency, the owners made the decision to repair the house and elevate it more than its pre-Katrina height so that the first floor is above the established flood risk level. This approach followed the historic traditions of both the house and the local community practice in response to flooding. Every effort was made to match the historic details of the foundation by using reinforced, square-brick piers with painted lattic screening between the piers and building up the ground level around the piers. The stairs access the porch in the historic location, but the new extended run necessitated by the increase in height is turned at a 90-degree angle below the landing, allowing a surviving tree to remain in front of the house.

Figure 2: View from the street in 2001 before Hurricane Katrina. *Credit: Ray Bellande/Ocean Springs Archives*

Figure 3: Hurricane Katrina destroyed the wrap-around front porch and knocked the house off the pier foundation. This photo was taken after the site had been cleared and windows and doors were temporarily boarded. *Photo: Mississippi Department of Archives and History, Mississippi Historic Resources Inventory (HRI) Database. http://www.apps.mdah.ms.gov/Public*

Figure 4: This photo of the hurricane damage shows that part of the roof was stripped away, and debris littered the site around the house. *Photo: Mississippi Department of Archives and History, Mississippi Historic Resources Inventory (HRI) Database. http://www.apps.mdah.ms.gov/Public*

Figure 5: A taller foundation was constructed to elevate the house above the established flood risk level. While the house is higher than it was historically, the change is still in keeping with the historic character of the house, which had been on a tall foundation historically. The change is also consistent with historic regional traditions of adapting buildings to flood events. Additionally, the details of the foundation, with the brick piers and painted lattice, matches features of the historic design. The stairs access the porch in the historic location, but the extended run required by the taller foundation is turned 90 degrees below the landing to allow a surviving tree to remain in front of the house. A small retaining wall behind the tree holds fill that was added around the house to mask some of the change in height. *Photo: Mississippi Department of Archives and History, Mississippi Historic Resources Inventory (HRI) Database. http://www.apps.mdah.ms.gov/Public*

CASE STUDY 4: COMBINED FLOOD ADAPTATIONS TO PROTECT A RHODE ISLAND LIVERY

LANPHEAR'S STABLE, WATCH HILL, RHODE ISLAND

Figure 1: Historic view of Lanphear's Stable. *Photo: Courtesy of The Watch Hill Preservation Society*

Figure 2: Aerial view showing the proximity of the bay to the historic livery, marked by the arrow. *Photo: Mott & Chace Sotheby's International Realty*

The oldest part of Lanphear's Stable, also known as Holdredge's Garage, was constructed circa 1885 in the village of Watch Hill, RI. The building housed a livery that catered to the needs of summer travelers visiting local hotels and resorts. By 1910 the building was enlarged to include additional stable and barn space, as well as an apartment for the owner and boarding house rooms for chauffeurs and groomsmen on upper levels. It is a contributing building within the Watch Hill Historic District listed in the National Register of Historic Places.

The former livery is sited on low ground in close proximity to Watch Hill Cove, and flooding is a significant concern. A rehabilitation project began in 2014 to address the flood risks and adapt the building into a mixed-use retail, office, and residential property. The established flood risk level for this property at the time of the project was approximately eight to nine feet above the existing grade.

A significant character-defining feature of the livery is the relationship between the building and the site. While the project team determined that elevating the building completely out of the flood risk was possible, it would alter that important relationship.

Instead, the building was lifted two feet above grade to provide some measure of flood protection while maintaining the historic character of the property and easy pedestrian access to the new retail spaces on the lowest level.

Elevating this 7,000-square-foot building was complicated, even though the frame structure is relatively lightweight and easy to separate from the existing stone foundation. Existing interior and exterior finishes were removed prior to work beginning. Historic materials were marked and stored for future reinstallation. With the structural components exposed, the building was stabilized and divided into five separate sections. Each section was lifted independently to a temporary height of eight feet above the ground.

This provided access underneath the building to construct a new foundation of helical piers supporting a reinforced concrete slab with spread footings.

Figure 3: The structure was lifted in sections several feet in the air to provide space and access for foundation work. *Photo: GNCB Consulting Engineers*

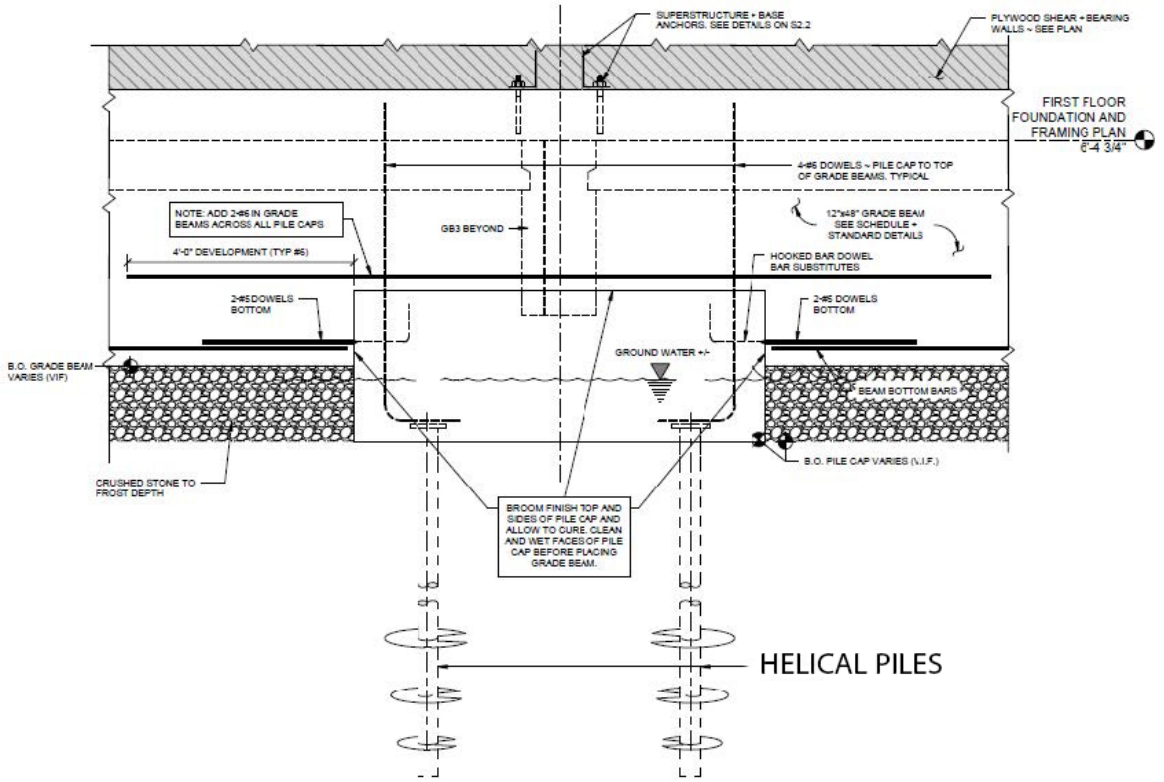


Figure 4: Cross section of the new foundation showing helical piers below spread footings and a reinforced concrete slab. *Drawing: GNCB Consulting Engineers*

Since elevating the building did not eliminate the flood risk to the first level of the building, the lowest level was wet floodproofed. This treatment included strengthening the ground-floor structural frame, installing engineered flood vents, and using flood-damage resistant materials at the floors and walls of interior spaces. The condition of the building before the project began required a substantial amount of replacement materials for deteriorated features and finishes. Almost all materials were replaced in kind with durable marine-grade wood.

Utilities and equipment were relocated to a new elevated mechanical room created in the back of the upper floor that required new exterior louvers for adequate ventilation.

By selecting a combination of flood adaptation treatments—elevating the building, wet floodproofing, and elevating utilities—the project team was able to preserve the historic character and features of Lanphear's Stable while making the building more resilient to future floods.

Figure 5: View of the building after the floodproofing and rehabilitation project was complete. The historic barn doors and many historic windows were preserved. Damaged or missing shingle siding was replaced in kind. The foundation is now two feet taller than it was at the start of the project. Wet floodproofing of the first floor provides additional resiliency and protection for floods that exceed the new elevation height. *Photo: Pariseault Builders*

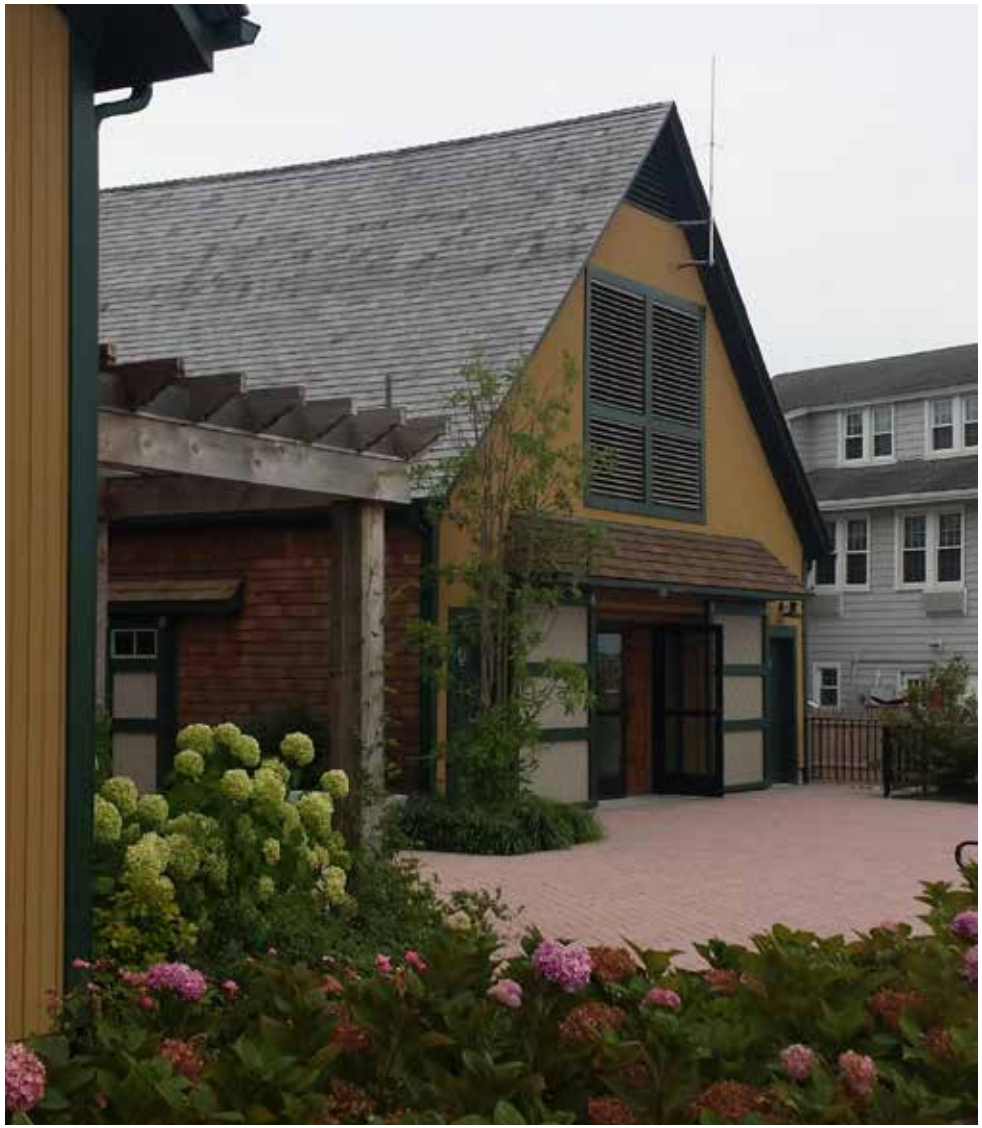


Figure 6: The mechanical room was relocated to the upper floor at the back of the building, discernible in this photo by the louvered vents. *Photo: Jennifer Wellock/NPS*

Figure 7: As part of wet floodproofing the building, engineered vents near the bottom of exterior walls are designed to allow water to flow in and out of the building during a flood. This allows water pressure to equalize on both sides of the wall and reduce stress to the structural system. *Photo: Jennifer Wellock/NPS*

U.S. Department of the Interior
National Park Service
Technical Preservation Services